

2007 Updated Edition, Draft

Urban Drought Guidebook

State of California

Department of Water Resources

Office of Water Use Efficiency and Transfers

This report was prepared in cooperation with the U. S. Bureau of Reclamation and California Urban Water Conservation Council

August 2007

If you need this publication in an alternate form, contact the Equal Opportunity and Management Investigations Office at TDD 1-800-653-6934, or Voice 1-800-653-6952.

Foreword

To prepare for the possibility of another dry year or water supply interruptions in 2008, the Department of Water Resources (DWR) is updating its Urban Drought Guidebook (Guidebook). DWR, the U. S. Bureau of Reclamation (Reclamation), and the California Urban Water Conservation Council (the Council) are working cooperatively to update the Guidebook and provide technical assistance to local water suppliers.

As water suppliers review and update their Water Shortage Contingency Plans, we hope that the new information and examples of exceptional efforts by water suppliers throughout California and the United States provided in this Draft Urban Drought Guidebook will be useful. The wide array of approaches presented in the Draft Guidebook represents the variable water supply and demand scenarios from one end of the State to the other. Accordingly, water suppliers will design programs that reflect local and regional conditions.

Additional drought information can be found at these websites: www.owue.water.ca.gov and www.cuwcc.org.

Please send comments and suggestions regarding this Draft Urban Drought Guidebook to David Todd of DWR's Office of Water Use Efficiency and Transfers at dtodd@water.ca.gov (916) 651-7027 or Marsha Prillwitz of the Council, marsha@cuwcc.org (916) 552-5885 extension 22 by November 1, 2007. The final version of the Guidebook will be released in January 2008.

Sincerely,

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Introduction

Much has changed in the realm of California water since the first edition of the Urban Drought Guidebook. Some of the situations and challenges facing water managers today include:

- On average, Californians use less water per person, but the State's population has grown from nearly 30 million in 1990 to over 37 million in 2007.
- 2006 was the hottest year on record in most of California and the United States.
- 2006-2007 was the driest water year on record in many California counties.
- Water is delivered through an increasingly complex and aging network of distribution systems.
- Water treatment processes have become more sophisticated and costly.
- Energy-related expenses, from transportation to treatment, have increased significantly.
- The environment is taxed to a critical point in some key waterways of the State, including the Delta.
- The reliability of water deliveries has diminished as uncertainty and variability increases, related to climate change, regulatory actions, system security and other factors.

There are also new opportunities for addressing water shortages since the 1990's. Widespread use of the Internet allows for information sharing and communication to a level unimagined in previous decades. New technologies allow for more efficient use of water in almost every sector, from commercial cooling towers to smart irrigation controllers. Regional alliances have been established, often on a formal basis, to coordinate water supply and demand management efforts.

This guidebook is intended to assist water managers facing the challenge of water shortages by employing tried-and-true methods of the past as well as making use of new tools and methods now available.

Water shortage management involves using programs to temporarily reduce demand and find alternate water resources to temporarily increase supply. This guidebook discusses water shortage management programs that belong in water shortage contingency plans. It was written in 1988, and then updated in 1991 and 2007 to help water suppliers cope with potentially severe drought and other water shortage conditions. The focus of this guidebook is to provide an orderly, step-by-step process to anticipate and respond to water shortages. The main text of the guidebook has two areas of emphasis: First, it uses examples of well-conceived and executed plans in California and other parts of the country to illustrate recommendations whenever possible. Second, it stresses that

successful programs are commonly the result of a cooperative effort between the water supplier and customers. Activities that foster this spirit of cooperation are highlighted.

Definition of a Drought

In the most general sense, drought is a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector. Whatever the definition, it is clear that drought cannot be viewed solely as a physical phenomenon. A water shortage occurs when supply is reduced to a level that cannot support existing demands. Natural forces, system component failure or interruption, or regulatory actions may cause these water shortages. Such conditions could last two to three months or extend over many years.

Even though the emphasis is on water shortages, some of the water shortage mitigation measures presented in the guidebook are also appropriate as part of a long-term water conservation strategy. Cost-effective, long-term water conservation efforts are valuable to a community in that the existing supply can provide improved reliability or support more users. However, as users become more water efficient or growth impacts supply reliability, a larger multi-year water storage drought buffer may be needed.

Water Shortage Contingency Planning

The essential role that a reliable water supply plays in supporting our society highlights the need for advance preparation for a drought or other water shortage. Such contingency planning allows pre-shortage selection of appropriate responses consistent with the varying severity of shortages. While the actions taken should be adequate to deal with the circumstances and no more severe than necessary, it is essential that water suppliers start demand reduction programs before a severe shortage develops. Water suppliers that delay instituting demand reduction programs may exhaust reserve supplies early in an extended shortage and could thus cause unnecessary social and economic harm to the communities. The Water Shortage Contingency Plan (WSCP) should enable water suppliers to provide water for public health and safety and minimize adverse impacts on economic activity, environmental resources and the region's lifestyle.

Here are sample priorities for use of available water:

- 1. Health and Safety interior residential and fire fighting
- 2. Commercial, Industrial, and Institutional maintain economic base, protect jobs
- 3. Permanent Crops takes five to ten years to replace
- Annual Crops protect jobs
 Existing Landscaping direct water to trees and shrubs
- 5. New Demand generally, two years of construction projects are already approved

Drought-Related Regulations and Planning Requirements

For California water suppliers, the requirements of Section 10632 of the Water Code of the State of California need to be incorporated into any water shortage plans. The key elements of these regulations are summarized in Table 1. The complete text of the relevant Code sections is contained in Appendix A. This chapter of the Code provides the authority for water suppliers to declare a water shortage emergency. Once having done so, the local water supplier is provided with broad powers to implement and enforce regulations and restrictions for managing the water shortage. Water needed for domestic purposes is given priority and discrimination within a class of customers is not allowed. Investor-owned water suppliers will find drought related information from the California Public Utilities Commission in Appendix B.

Table 1 Outline of California Water Code, Chapter 3

Section	
Reference	Summary of Key Points
350	Governing body of water supply distributor has authority to declare water shortage emergency condition.
	Defines water shortage emergency condition as when there would be "insufficient water for human consumption, sanitation, and fire protection."
351	A public hearing is required prior to a water shortage emergency condition declaration.
352	Advertisement of the public hearing must follow certain notification and distribution procedures.
353	Governing body of water supply distributor shall adopt regulations and restrictions to "conserve the water supply for the greatest public benefit."
	Priority uses are domestic, sanitation, and fire protection.
354	Option given to governing body of water supply distributor to establish additional water allocation, distribution, and delivery priorities.
	Method of allocation cannot discriminate "between customers using water for the same purpose or purposes."
355	Regulations and restrictions are in effect until, the emergency is over and the water supply has been replenished or augmented.
356	Regulations and restrictions allow prohibiting new or additional service connections.
	Enforcement of regulations and restrictions may include discontinuing service to customers willfully violating them.
357	Regulations and restrictions shall prevail over allocation provisions of laws pertaining to water rights of individual customers.
	Water distributors subject to regulation by the State Public Utilities Commission (PUC) need prior approval by the PUC before adopting regulations and restrictions of this type.
358	Review of an emergency declaration or adopted regulations and restrictions adopted by a court is not prohibited.
359	Requirements for applying for Federal drought relief program.

Since 1983, every urban water supplier that provides water to 3,000 or more customers, or that provides over 3,000 acre-feet of water annually, has been required to develop and implement an Urban Water Management Plan (UWMP). The California Department of Water Resources (DWR) provides a guidebook, conducts workshops, and serves as a repository for the plans. The law requires suppliers to report on the reliability of its water service and whether it is sufficient to meet the needs of its customers during normal, dry, and multiple dry years. Water suppliers update their UWMPs every five years.

The Urban Water Management Planning Act describes the contents of UWMPs as well as how urban water suppliers should adopt and implement the plans. An important requirement is that each water supplier must prepare a WSCP. The WSCP includes six components:

- 1) A description of the stages of action an agency will take in response to water shortages
- 2) An estimate of supply for three consecutive dry years
- 3) A plan for dealing with a catastrophic supply interruption
- 4) A listing of the prohibitions, penalties and consumption reduction methods to be employed
- 5) An analysis of anticipated revenue impacts of reduced sales during shortages and proposed measures to overcome revenue impacts
- 6) The process to be used to monitor and document water cutbacks

Final versions of the 2005 UWMPs of over 100 water suppliers, including their WSCPs, can be viewed at: http://www.owue.water.ca.gov/urbanplan/index.cfm.

Integrated Regional Management Plans are being developed and implemented throughout the State, partly in response to Proposition 50, a statewide bond that provides funding to encourage a regional approach to water management. Regions have distinctive identities and hydrologic and ecologic connections. Water supply reliability is a primary water management objective to be considered in these integrated plans. Meeting dry year demands is an important component of water supply reliability. UWMPs and the associated WSCPs prepared by local water suppliers provide an important foundation for Integrated Water Management Plans.

A noteworthy regional water management effort is the "One Water, One Watershed" project of the Santa Ana Watershed. It brings together three California counties, 69 cities, and 98 water suppliers, covering 2,800 square miles, to develop regional partnerships to address the water supply and quality challenges. The major challenges threatening water supply reliability are identified as climate change, continued drought in the Colorado River basin, Bay Delta vulnerabilities, and population growth and explosive development. The goal of "One Water, One Watershed" is to create a sustainable Santa Ana Watershed that will be drought-proofed, salt-balanced, and will support economic and environmental viability through the year 2030. For more information about this innovative project, go to http://www.sawpa.org/html/OneWater.htm.

In addition to the importance of UWMPs to regional water management plans, the UWMPs are also important reference points for land use planning. The approvals of large

new developments in California must be linked to assurances that there is an adequate water supply (Senate Bills 610 and 221, 2001 - http://www.owue.water.ca.gov). If the proposed project was not accounted for in the most recently adopted UWMP, the project is required to discuss whether the water supplier's total projected water supplies available during normal, single dry, and multiple dry water years during a 20-year projection will meet the projected water demand associated with the proposed project. Without assurances that there is a reliable source of water, even in dry years, large development projects cannot proceed.

Planning Process and Implementation Steps

The chapters of this guidebook describe in detail a step-by-step planning process designed to guide water supplier actions during pre-drought and drought stages. WSCPs all contain specific mandatory requirements and penalties that become effective when certain shortage conditions (triggers) occur. Essential elements of the planning activity are summarized below.

Water shortage planning is a dynamic process that is constantly evolving as conditions change and new information becomes available. Step 1 calls for the formation of a 'water shortage response team' with a designated leader to spearhead the effort and involve the various units within the organization. In Step 2 water suppliers collect supply and demand data. This activity is needed as a basis for planning and estimating how much water of acceptable quality will be available under various shortage conditions, including multi-year shortages. Physical constraints, such as pumping and pipeline capacity, are considered as well as basic supply and demand information. Calculating projected demand, including increases due to growth and reduced precipitation, will be balanced against projected supply. **The best time to initiate this process is before a shortage occurs.**

Steps 3 and 4 involve assessing shortage mitigation options and setting drought stage triggering levels. These can be parallel efforts that support the final selection of WSCP elements in Step 5. Step 3 examines not only the quantity of water available from various supply augmentation and demand reduction options, but any problems or constraints resulting from the use of such sources. Identification of "trigger" mechanisms to react to shortage severity is covered in Step 4.

Step 5 represents the synthesis of information from previous steps. Groups of water-saving measures are associated with progressive levels of supply shortage. The key element of this step is involvement of customers in order to create a program that the community understands, contributes to, and supports.

Step 6 is when the implementation budget is developed and the draft plan is presented to the public for review and revision. Formally establishing the ordinances and interagency agreements that underlay the plan happens before Plan adoption.

The "nuts and bolts" of plan implementation are considered in Step 7. Procedural issues, staffing needs, and budget and funding considerations must be resolved. The preparation and implementation of a plan requires many complicated actions and it is recommended that the supplier begin planning at least six months before rationing commences.

Involve the Public

Public involvement is clearly required for smooth implementation of all phases of a demand reduction program. Community participation at the program development stage is also important. Public involvement will, to a large extent, determine the effectiveness and equity of the water supplier's water shortage management program.

STEP 1: Establish a 'Water Shortage Response Team'

Selecting the Water Shortage Response Team

Effective water shortage planning and implementation requires a water supplier to:

- Designate a water shortage response team leader to lead the team.
- Establish a water shortage response team of senior staff representing all departments.
- Provide the water shortage response team with funding and staff.

Selecting a water shortage response team leader is the critical first step. The water shortage response team leader is someone who the water supplier's board of directors and general manager are willing to have speak for the supplier on the nightly news, lead meetings at which hundreds of concerned customers provide comments and suggestions, and organize and manage a multi-year shortage response program. This person is someone who is able to work with and motivate all agency staff, communicate the importance of working together to agency staff and the community, handle multiple simultaneous complex situations, deal with the public calmly and consistently, and gain the support of local businesses and groups.

Developing a specific, detailed WSCP requires collecting and analyzing water supply, demand and use information and understanding the agency's budget, costs and sources of income. Most suppliers have a general WSCP but when drought conditions signal that the WSCP may need to be implemented it is time to revise the plan to be specific to the current drought. The types of information needing review include:

- Supply reliability: which can change year to year.
- Demand: which may increase due to growth or decease due to efficiency programs.
- Revenue: it may have changed due to new rates and the shortage contingency fund may be depleted.
- Infrastructure status: areas in need of repair or subject to pipe breaks may aggravate shortage.
- Emergency supplies: which are usually not available until needed.

Every department of the water supplier will be involved in developing the specific water shortage response plan and in implementing the plan. For instance, the billing department will have to change the billing format so that customers can compare their monthly water use with the targeted reduction; meter readers may have to read meters monthly instead of bi-monthly; computer programmers will have to develop new account databases to

track customer's penalty charges and rebate program participation; human resources may need to hire temporary staff; and engineering may be deepening wells, installing new water treatment devices and designing system interconnections. Operations may need to accelerate capital improvements or add leakage repair crews as drying soils create more stress on pipes. The water conservation staff will be essential in many of these actions. The implementation of a water shortage response program will probably affect every staff member's job responsibilities.

The water shortage team members will probably include:

- General Manager Overall direction on the response.
- Water Shortage Response Team Leader

 coordination, information gathering and dissemination, key support staff assignments, role clarification, and communication with broad array of interested parties.
- Water Treatment Manager Overall guidance on drinking water quality and operations, issues related to potential alternative supplies, and opportunities for use of non-potable water.
- Finance Manager Cost estimates for supply alternatives and demand reduction programs, customer data base improvements and bill format changes, expected lost revenue estimates, recommend rate changes, use of the revenue stabilization fund.
- Conservation Manager water use reduction measures management, cost estimates to achieve demand reductions, and liaison with green industry and large water users (residential & commercial, industrial and institutional (CII) customers).
- Planning / Engineering Manager new connection water use projections, new and expanded supply infrastructure, interconnection planning, water quality treatment improvements.
- Operations Manager meter reading frequency, meter accuracy, system water loss audit and repair
- Communications Director (wholesale and large retail agencies) Messaging, customer relations, media relations, press releases, and coordination with wholesale customers.
- Environmental Review (wholesale and large retail agencies) Review supplemental supply projects and prepare environmental documentation.

Setting Agency Priorities

The water supplier's primary demand reduction program focuses on providing customers with programs and knowledge that help them to reduce their use while still allowing them flexibility and choice in how water is used. Public support and cooperation is likely to be

higher if actions are equitable, i.e., all water users are experiencing a similar service level and degree of hardship.

Given clear, timely and specific information on supply conditions and the necessary actions to forestall increase reductions, customers prefer the opportunity to meet targeted demand reduction levels through **voluntary** compliance measures. The decision to move to mandatory restrictions is more acceptable if the voluntary approach has been tried first but has not resulted in enough demand reduction to ensure public health, safety, and environmental protection through the projected duration of the shortage.

In 2002, the Board of Water Commissioners adopted a policy stating that Denver Water's goal for drought response is to preserve the quality of public life and economic activity to the extent possible in the face of water shortage. The Drought Response Plan outlines specific measures designed to maximize available water supplies and minimize water use. Because every drought is different, the Board will adjust and refine drought response measures based on actual conditions.

Denver Water's prime response to drought is to budget water use so supplies will be available for the most essential uses. The water use restrictions imposed during the 2002–2003 drought indicated that no single "silver bullet" was effective at encouraging all customers to reduce water use. Instead, a "basket of programs"—restrictions, surcharges, enforcement, incentives, and monitoring and evaluation—is recommended to create an overall atmosphere that encourages water savings.

The Board adopted a set of principles to guide the development of drought restrictions:

Avoid irretrievable loss of natural resources.

Restrict less essential uses before essential uses.

Affect individuals or small groups before affecting large groups or the public as a whole, allowing as much public activity as possible to be unaffected.

Minimize adverse financial effects on the community.

Eliminate water waste.

Maintaining Momentum

Implementing the water shortage response program will require three to six months of effort. For instance, if rationing is planned to take effect on May 1 of any year, the water shortage response team would need to begin work no later than November 1 of previous year. Step 7 contains detailed implementation plans. Use these plans as targets and set completion dates element of the implementation plan.

Coordinate, Cooperate and Communicate

The development of a good plan is contingent upon coordination, cooperation and communication with the community, within the agency, among local agencies, and regionally.

STEP 2: Forecast Supply in Relation to Demand

Water shortage contingency planning is the process of defining responses to a whole array of "what if?" scenarios. The key to making a wise decision when faced with a specific situation is good planning backed by accurate data.

However, what used to be considered good predictions based on historical data now has a new level of uncertainty - the new reality seems to be increased variability of precipitation. Water suppliers will want to build in increased uncertainty when implementing the following procedure.

Both historical information and information on current conditions are necessary for this process. Historical data can be used to generate a reasonably precise definition of "normal" versus "drought" characteristics. Review of the present status is used to estimate how much water of acceptable quality will probably be available. Both sets of data are used to create water shortage scenarios. This chapter reviews the data needed to assess possible water shortage scenarios and useful calculations necessary for interpretation of such data.

More suppliers are now considering the potential effect of climate change when determining the reliability of their water supply.

I. Data Collection

Data concerning the water supply, treatment flexibility, distribution system, and customer characteristics are compiled and used for building a shortage-planning database. General categories of information include:

Supply Data

- Facilities data.
- Supply status and forecast information from water wholesalers.
- Stream flow.
- Reservoir levels.
- Ground water table elevations.
- Soil moisture.
- Precipitation records and forecasts (rainfall & snowpack).
- Water quality.

The National Drought Mitigation Center at the University of Nebraska, Lincoln produces the U.S. Drought Monitor, a map of the US with a graphic display of the intensity of drought in various regions and a summary of drought conditions. The Center also

provides useful information about drought planning and climate change. Their Web site address is http://www.drought.unl.edu/.

Two of the most comprehensive sources of historical information for California are *California Climatological Data* available at the US Department of Commerce National Oceanic and Atmospheric Administration National Weather Service web site at: http://www.weather.gov/view/states.php?state=CA and *Water Resources Data — California* which is in *Water Resources Data for the United States, Water Year 2006*, that is available at the U.S. Geological Survey (USGS) web site at: http://ca.water.usgs.gov/. The Water Supply Outlook DWR California Data Exchange Center at http://cdec.water.ca.gov/ complements the USGS publication in that it presents DWR gathered data.

Water Conditions in California provides current information and runoff forecasts for the water year and is available at http://watersupplyconditions.water.ca.gov/. Another DWR publication, California Water Supply Outlook provides current information on hydrologic conditions such as snowpack, runoff, and reservoir storage and is published twice each month. Appendix F summarizes State and federal agency Web sites that may be useful in supplying data during water shortage emergencies.

The body of historical information summarized in the various DWR publications previously discussed is continuously updated and available at: http://www.publicaffairs.water.ca.gov/information/pubs.cfm.

Demand Data

- Production records and forecasts.
- Water use records and forecasts.
- Service area population and growth projections.
- Customer class characteristics.

Water use data in needed by month (or as often as is available) for <u>each customer</u> for at least the last five years. This data is used to determine, for individual customer and customer class, the average use by month, by season and by year. Collect the following data:

- The average number of residents per single-family residence and per multifamily unit.
- The number of units per multifamily connection.
- The number of businesses served by each commercial meter and the number of employees at each business.
- The number of acres irrigated by each landscape irrigation meter and each agricultural meter.

- The annual quantity of unaccounted for water (UAW) by subtracting sales + flushing + measured fire/leaks/breaks from production.
- If there is time, the accuracy of the various sizes and ages of meters. Calibrate all 4-inch and larger meters.

II. Data Analysis

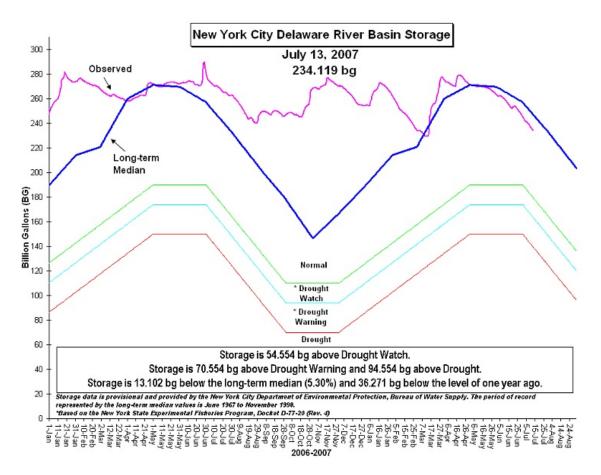
Much of the information discussed previously is routinely collected and analyzed as part of periodic facility planning (water master plans, wastewater master plans); UWMPs, and general plan updates. Coordinate the development of a *drought-planning database* with ongoing data collection and analysis programs. If not previously determined in other studies, analysis of the raw data may be required to illuminate certain drought period trends (i.e., the relation of landscape irrigation to precipitation).

Supply Data Analysis (projected dry-year supply without augmentation)

First, determine the current reliable yield for each source for the next three to five years. Assume a repeat of the worst historical drought but include an adjustment for the increased uncertainty and variability. For purchased water sources, do not use the contracted allocation but ask the water wholesaler to provide estimates of how much water is likely to be available during each of the next three to five years. A supply curve can make complex data more understandable.

DRAFT August 27, 2007

Delaware River Basin Storage Levels



Water Quality Data Analysis

Establish treated water quality by source for constituents regulated by the Safe Drinking Water Act (PL 93-523) and Title 22 of the California Administrative Code. Comparison of this information with raw water data gives insights into the seasonal variability of the supply and the ability of the treatment system to respond to changes in raw water quality. Develop data on how the water quality of each source may vary with the 2008-2012 use projections. The ability to treat water of degraded quality adequately during drought will be critical if the agency plans to use all possible supplies. Identify process or chemical changes needed to respond to reduced raw water quality and new supply sources.

Suppliers that blend water from various sources will have to examine the ability of the treatment system to meet water quality standards when lesser quality water is delivered from one or more sources. Also, certain commercial or industrial customers may need advance notification if the water quality characteristics will be significantly different during drought periods.

To stay informed of drought-induced water quality issues, a water supplier may decide to temporarily expand its routine water quality-monitoring program. This information may also be useful in alleviating customer concerns if aesthetic differences in water quality, such as chlorides, hardness, and odor occur during a drought. Increased testing will also provide data on possible impacts of varying water quality on the agency and customer distribution systems.

Water Demand Data Analysis (projected dry-year demand without demand reduction programs)

The more information that is known about how customers use water, the better the demand projections and selection of appropriate demand reduction measures will be. At a minimum, identify customer type and their seasonal demands. Standard water supplier customer types include: single family residential, multifamily residential, commercial, industrial, institutional, landscape, recycled, agricultural and wholesale.

From a review of water use records, specific water use factors can be determined for each user type on an average monthly, seasonal and annual basis. Knowledge of user characteristics will be helpful when assessing the demand reduction impacts of restrictions and rationing allocation methods and estimating revenue generation from pricing changes and water shortage surcharges. Common units of water use measurement, in order of usefulness, are:

Gallons per capita per day (gpcd)

Gallons per day per dwelling unit (gpdd)

Gallons per day per connection (gpdc)

Gallons per day per irrigated acre (gpda)

Gallons per day per employee (gpde)

Further analysis of a given category, such as determining individual subarea factors or correlating customer classes with land use designations, may be useful. This is especially important if a large proportion of the overall demand is generated by one or two customer class types.

Analyze water use records on a seasonal basis. Again, conducting this analysis by customer type is essential. Winter residential use compared to summer residential use gives a good indication of indoor versus outdoor usage. The same analysis of seasonal water use among industrial customers may be indicative of process changes or landscape irrigation.

Demand for water usually increases in a dry year over normal demand. This is because more water is needed for landscape irrigation due to less than normal precipitation during the spring and fall. Drought year demand will increase the most in areas such as inland valleys and desert areas that ordinarily use a high percentage of water for landscape irrigation.

To forecast drought year demand, it may be helpful to plot normal year consumption in the service area and overlay this with any existing data on demand in previous drought years. Agencies may be able to plot full supply periods against data from the drought period 1987-1990 (California's last major statewide drought. At a regional level, parts of Southern California experienced a series of consecutive dry years in the late 1990s/early 2000s. Other significant droughts occurred during 1928-34 and 1976-77.) However, if the water supplier implemented demand reduction programs or the media publicized the need to reduce use, the dry year demand information will not reflect unmitigated demand. Keep in mind that demand will have increased due to growth in the service area. Project the dry year increase for each customer type.

III. Is There a Predicted Shortage?

A supplier's projected supply for the next five years, when compared with projected demand for the next five years, provides data on the yearly (or monthly) supply/demand balance. In some cases these projections may show that the supplies will be adequate. It is more likely that during significant droughts suppliers will find the supply deficit will vary year to year but gradually increase as reserve supplies dwindle. The predicted unmitigated annual supply deficit is then met with supplemental supplies and demand reduction programs. A combination of supplemental supplies and reduced demand is used to balance supply and demand.

A "mitigated supply" is the normal dry year supplies plus emergency supplies. "Mitigated customer demand" is the projected dry year demand minus reductions resulting from demand reduction programs. The combination of emergency supplies and reduced demand is planned to balance supply and demand.

A closely coordinated effort between water wholesalers and retailers is essential. Where they exist, water wholesalers may take the lead and ask their retail customers to share in developing regional and supplier specific water shortage response plans. However, since most retail agencies have multiple sources of supply (wholesale, groundwater, and local surface) they can prepare for water shortage without waiting for their wholesaler to take the lead. This section discusses how various water suppliers utilize supply and demand data to guide their response to a supply shortage. In the case where water suppliers have control over their supply systems, they assume the role of both water wholesaler and water retailer.

Cooperate with other Agencies

Suppliers are entering into regional, county and local agreements to improve water supply management, share the cost of emergency supplies, and improve demand reduction media messages and program cost.

In 2004 El Dorado County Water Agency, the El Dorado Irrigation District, Grizzly Flats Community Service District, and Georgetown Divide Public Utility District initiated a collaborative drought planning process that identifies actions that can be pursued individually or jointly. They are exploring the use of a model to anticipate real world drought impacts through drought simulations.

The El Dorado Irrigation District is now extending their drought preparedness analysis to include a regional climate scenario, incorporating precipitation, temperature, and hydrology factors derived from 12 internationally recognized climate change models.

In July of 2007, Bay Area water suppliers unveiled a regional public education campaign aimed at reminding residents and businesses to curb water use. The new "Water Saving Hero" campaign features ordinary people adopting simple water conservation practices in their everyday lives. The messages appear on billboards, transit stations, buses, trains, newspapers and are on the radio. A new website, www.WaterSavingHero.com, links Bay Area residents to their local water supplier's conservation tips and cash rebate information. The million dollar campaign is a partnership among Bay Area water suppliers and organizations including the San Francisco Public Utilities Commission, Bay Area Water Supply and Conservation Agency, Santa Clara Valley Water District, Contra Costa Water District, Zone 7 Water District, Bay Area Clean Water Agencies and others.

Actions by Water Wholesalers

In California, wholesalers manage source supplies or supplies from primary water suppliers such as the State Water Project, the Central Valley Project, and the Colorado River system.

Water wholesalers can offer the following types of leadership before and during a water shortage:

- Develop an allocation process with retailers.
- Provide retail agencies with regular updates to wholesale water supply availability.
- Coordinate a consistent regional message and/or media-market basis.
- Coordinate supplemental supply purchases and agency interconnections.
- Coordinate regional demand reduction strategies.
- Coordinate financing for joint supplemental supply and demand reduction projects.
- Coordinate regional or area wide demand reduction projects.

Actions by Retail Water Suppliers

Each water retailer must make its own determination that the possibility of a water shortage exists and adopt a current and specific WSCP. Managing supply and demand in a drought is difficult and the following procedure is recommended.

Consider Carryover Storage

The water supplier must also decide how much of the current year supply can be carried over as insurance against a possible subsequent drought year. At absolute minimum, the carryover amount will be enough to meet essential health, safety, and firefighting needs if the subsequent winters are as dry as the driest years on record.

Climate Change

The potential impact of climate change on California's water resources is another consideration that some water suppliers are exploring. It is anticipated that one of the impacts of the more variable weather patterns associated with climate change will be longer, drier droughts. More information can be found at this DWR Web site: http://www.climatechange.water.ca.gov/.

The San Francisco Public Utility Commission (SFPUC) has embarked on a project to incorporate global warming concerns into their forecasting and planning activities. The SFPUC has evaluated the effect of a 1.5 degree Celsius temperature rise between 2000 and 2025 on the Hetch Hetchy watershed at various elevations. It anticipates that with this rise in temperature, there will be less or no snowpack below 6,500 feet and faster melting snowpack above 6,500 feet. As such, SFPUC estimates that about 7 percent of the runoff currently draining into Hetch Hetchy Reservoir will shift from spring and summer seasons to the fall and winter seasons in the Hetch Hetchy Basin. This shift is manageable within SFPUC's planning models, but other water suppliers with storage at lower elevations could be harder hit, especially during longer, dryer drought periods.

Similarly, the Santa Clara Valley Water District, the agency that supplies water to much of Silicon Valley, has begun incorporating the possible effects of climate change into its water management plans, much as it already does for earthquakes and flooding. It is partnering with Sustainable Silicon Valley's CO2 Initiative, a key strategy to respond to climate change by changing the way energy is consumed. The focus is on both energy and water efficiency.

IV. Catastrophic Supply Interruptions

California water suppliers are required to develop plans to cope with catastrophic supply interruptions. Plans are required to be designed for shortages up of to 50 percent.

Preparing for Uncertainty

System interconnections with agencies in the region and participation in comprehensive regional disaster plans can help minimize the effects of catastrophic supply interruptions. In addition to predictable catastrophes such as floods, earthquakes, power outages and contamination, the physical destruction of facilities as a result of terrorism has taken a higher profile in recent years.

In 2007, Orange County experienced an interruption in service due to a weeklong shutdown of a local water treatment plant coupled with a pronounced spike in water usage. This crisis led county water officials to request that the transportation department activate 35 message boards along five major freeways reading, "ORANGE COUNTY WATER EMERGENCY: CONSERVE WATER." The signs seem to have done the trick. In addition to the freeway signs, which Caltrans officials said had never before been used for such a purpose, an official also attributed the success of the conservation effort to various cities and water districts that had brought in temporary pumps to help push water to areas where it was needed.

WARN, the *Water/Wastewater Agency Response Network*, supports and promotes statewide emergency preparedness, disaster response, and mutual assistance matters for public and private water and wastewater utilities. California is divided into six regions that coincide with the California Office of Emergency Services regions. Their website can be found at www.calwarn.org.

STEP 3: Balance Supply and Demand: Assess Mitigation Options

The ability to temporarily augment supply or reduce water demand is specific to each water supplier. This chapter presents a discussion of these two general types of water shortage mitigation options to be reviewed for applicability. Appendices D and J provide more complete descriptions of many of the measures.

Some water suppliers already have experience with some of these programs and principles and may offer valuable insights as to effectiveness and customer reaction. Appendix E is a listing of published information pertinent to water shortage management and water conservation. A WSCP that has a track record establishes a foundation for effective water shortage management.

Even though the emphasis is on water shortages of finite duration, some of the water shortage mitigation measures presented in this guidebook are also appropriate to be used as part of a long-term water conservation strategy. Cost-effective long-term water conservation measures are valuable to a community in that a given amount of supply can support more users or be available for reserves. However, care must be taken when instituting a WSCP concurrently with a long-term water conservation plan. All water suppliers should maintain a multi-year drought water supply buffer whenever possible. Water suppliers where growth impacts supply reliability or whose customers are already highly efficient will want to do additional planning.

Supply Augmentation Methods

Methods of supply augmentation can be classified into three groups: (1) increase existing supplies, draw from reserve supplies or develop new supplies, (2) increase supplier water use efficiency, and (3) cooperate with other agencies. Table 2 lists several examples of these methods. Appendix D contains a discussion of supply augmentation measures. Implementation of supply augmentation is often difficult because few of these actions can be undertaken quickly. Also, many of these methods involve balancing environmental and jurisdictional considerations. Finally, if reserves are used, these resources must eventually be replenished.

Consider whether or not the proposed action constitutes a "project" pursuant to the California Environmental Quality Act (CEQA) § 15378 (Appendix C). CEQA also defines those actions that are exempt from specified environmental review requirements in §15269 with three specific emergency exemptions:

- 1. Emergency repairs to public service facilities necessary to maintain service.
- 2. Projects carried out by a public agency to maintain, repair, restore, demolish, or replace property damaged or destroyed in a disaster in which a state of emergency has been proclaimed by the Governor.
- 3. Specific actions necessary to prevent or mitigate an emergency.

Certain drought response actions may not be exempt from CEQA and it is important to review the pertinent sections of the CEQA Guidelines for additional information regarding what constitutes an emergency before proceeding.

Despite the inherent difficulties with using supply augmentation options, even minimal supply augmentation programs have been helpful in water shortage situations. Developing extra supply increases utility credibility with customers by demonstrating that the water supplier is maximizing its efforts to deal with the water shortage. Also, supply augmentation can provide a water shortage buffer in case of multi-year shortages or can be used to minimize the amount of demand reduction needed to meet temporary supply deficits.

Increase existing supplies, draw from reserves and develop new supplies

Suppliers with surface water supplies may be able to use the amount of reservoir dead storage down to the legal minimum pool. Lake Cachuma, a Reclamation reservoir in Santa Barbara County, was supplied with a floating pump and pipeline to move dead storage water almost a mile back to the reservoir outflow.

Groundwater wells can often be deepened and the pump-rate increased for limited time periods. Lower quality groundwater can be blended or special treatment devices installed. In adjudicated basins it is sometimes possible during emergencies to temporarily increase the annual amount pumped.

It may be possible to attract new recycled water customers during a drought. Due to Department of Health Services regulations on recycled water use, landscape irrigation with recycled water is probably already more efficient that potable water irrigation use. If recycled water use customers are only reduced by the amount they exceed the landscape demand then they will not be penalized for their efficiency and will benefit from their recycled water system investments.

The best possible solution is to have emergency supplies held in reserve. These are often held in local groundwater basins but can also be located in distant water banks.

During extreme shortages expensive new water supplies may be the only solution to meeting demands. Desalination, brackish water nano-filtration, temporary pipelines, and

even water importation by train or truck become affordable. Nano-filtration can also be used to improve the quality of recycled water, expanding the number of possible customers. Water transfers from willing sellers using available pipeline capacity has become a significant source of supplemental water during shortages.

Increase Supplier Water Use Efficiency

To win the public's cooperation, water suppliers and municipal agencies can demonstrate a visible commitment to efficient water use. Actions to make a utility's operating system more efficient save water and set a good example for the public. A utility company can take actions itself to conserve water before asking customers to do the same, demonstrating a leadership role. One example is to reduce or stop turf irrigation and install low volume irrigation systems for shrubs and trees at all agency facilities.

System water audits can identify major water losses. Once a supplier quantifies their system losses, it is time to conduct a leak detection and repair program and possibly a meter replacement program. Detailed information on these procedures can be found at the CUWCC Web site at: http://www.cuwcc.org/m_bmp3.lasso

Information about publications at:

http://www.cuwcc.com/publications/action.lasso?-Database=cuwcc_store&-Layout=CDML&-Response=welcome2.lasso&-AnyError=error.html&Business_Serial_ID=10185&-Search.

When appropriate, implement water theft prevention programs, generally targeting street cleaners, water trucks, and construction sites. These programs save water and have high visibility. Thus they complement the public education programs.

A supplier can reduce water main flushing to the extent permissible by health and fire standards, recycle water used to backwash filters, and flush existing wells to develop the maximum flow possible. Limit landscape irrigation at water supplier facilities to appropriate plants and be efficient and run-off free as much as possible.

Water suppliers can reduce system pressure to the extent permissible by fire-fighting standards. Comparison of water use records of two similar Denver neighborhoods indicated that homes with lower water pressure utilize an average of 6 percent less water than those with higher pressure.

The South Florida Water Management District Water Shortage Plan requires system pressure reductions when there is even a moderate water shortage. Water authorities are asked to reduce pressure to 45 psi at the point of use (i.e., the meter). The utility then notifies local fire departments to make arrangements to restore pressure quickly in case of fire.

Avoid using pressure reduction as a conservation measure during Stage I or Stage II programs because reduced pressure may cause irrigation systems to function poorly.

Table 2 Supply Augmentation Methods

Supply Augmentation Method	Examples
Increase existing supplies, draw from	Increase groundwater pumping
reserve supplies or develop new supplies	2. Increase use of recycled water
	3. Require use of nonpotable water for nonpotable uses
	4. Build emergency dams
	5. Reactivate abandoned dams
	6. Employ desalination – land or ship based
	7. Import water by truck
	8. Rehabilitate operating wells
	9. Deepen wells
	10. Add wells
	11. Reactivate abandoned wells
	12. Renegotiate contractually controlled supplies
	13. Use reservoir dead storage
Increase supplier water use efficiency	Conduct distribution system water audit
	Conduct distribution system leak detection and repair
	3. Reduce distribution system pressure
	4. Replace inaccurate meters
	5. Minimize reservoir spills
	6. Suppress reservoir evaporation
	7. Recirculate wash water
	8. Blend primary supply with water of lesser quality
	9. Transfer surplus water to areas of deficit
	10. Change pattern of water storage and release operations
	11. Stop turf irrigation at Supplier facilities
Cooperate with other agencies	Negotiate purchases or 'options'
	2. Arrange for exchanges
	3. Establish transfers or interconnections
	4. Employ mutual aid agreements

Demand Reduction

Demand reduction is the most straightforward way to address water shortages. Curtailment of water demand is directed at supplier and customer uses that are inefficient, wasteful, or able to be temporarily reduced or suspended. Since the supplier may mandate certain demand reduction actions, enforcement mechanisms are needed for maximum effectiveness of those actions.

Demand reduction programs vary by Stage (severity of shortage). Stage 1 is usually voluntary and relies on a public information campaign. Stage 2 can often be managed with a more intensive public information campaign and mandatory restrictions. Stage 3 and Stage 4 most often require customer allocations and severe landscape irrigation restrictions. Demand reduction measures to assist customers reduce demand are offered in all stages but increase in scope with the severity of the shortage.

Plumbing hardware changes can also yield considerable savings. For example, one private college dormitory near Santa Barbara installed 350 ultra-low flush toilets for 1400 students and had immediate water savings of 30 percent. Providing home water audits, free hose nozzles and buckets, rebates for efficient plumbing fixtures and appliances, and gray water information can reduce residential use by up to 50 gpcd without significant lifestyle changes.

The State of Florida has established a process to prioritize demand reduction actions. On April 17, 2007, the State of Florida released the *Florida Drought Action Plan*. Each of the five water management districts in Florida approves plans and rules for addressing water shortages. Concern in Florida has risen, as November 2005 to March 2007 ranks as the third driest period in the State's recorded history. The goal of the State of Florida is to monitor and assess data from the five water management districts, coordinate drought management activities, communicate with decision makers and others and take actions to reduce adverse effects. An interesting and useful component of the Florida Drought Action Plan is the Recommended Water Conservation Alternatives table (http://www.dep.state.fl.us/drought/news/2007/files/florida_drought_action_plan.pdf). It presents the various agricultural and urban water conservation alternatives and ascribes a priority rating based upon the potential amount of water to be saved, the cost effectiveness of the measure, and the ease of implementation. Conservation rate structures, incentives, statewide irrigation design and installation standards, and metering of reclaimed water services are some of the "high" priority measures.

Public Information Campaign

A public information campaign is the most common water shortage program. Benefits of public information campaigns include rapid implementation with no direct cost to the customer and raising public awareness of the severity of the water shortage. Savings from this measure alone ranged from 5 to 20 percent, depending upon the time, money, and effort spent.

Examination of water reductions in Goleta during the 1987-92 drought shows that when the public perceives the drought to be severe, behavioral changes (such as flushing the toilet less often) can be achieved.

Voluntary measures are normally effective only when the public is convinced that a critical water shortage or drought exists. This can be accomplished by letting the public know how many days of supply remain, or showing them pictures of near-empty reservoirs. These types of photographs were successfully employed in Santa Barbara

County during 1990 to urge the public to reduce water use. Commonly encouraged conservation actions for various customer types are summarized in this section.

Restrictions

Ordinances banning specific uses of water are forms of mandatory measures. Examples of types of demand reduction ordinances are listed below.

Water Waste Ordinances

Ordinances making water waste illegal vary but often read as follows:

Waste of Water Prohibited. No water shall be wasted. All water shall be put to reasonable beneficial use. Prohibited water uses include, but are not limited to, the following:

- Use of any ornamental fountain using potable water for operation or make-up water.
- Car washing except at commercial car wash facilities that recycle water.
- Use of potable water from hydrants for non-potable uses.
- Washing of sidewalks, streets, decks or driveways (exemption for public health and safety).
- Pressure washing of buildings (possible exemption for building rehabilitation project painting).
- Untended hoses without shut-off nozzles.
- Gutter flooding.
- Sprinklers irrigation whose spray pattern hits paved areas.

Landscape Irrigation Ordinances

- 1. Watering only between certain hours or on specific days: During 1988 the City of San Luis Obispo limited landscape irrigation to every other day and water use increased. Odd/even or thrice weekly watering limitations often result in increased water use because they encourage customers to irrigate when they otherwise might not. Twice weekly is recommended if irrigation is allowed. During advanced stages sprinkler irrigation can be restricted to once weekly, or eventually banned. Micro irrigation of shrubs and trees can be encouraged as this will be a permanent efficient change. The Water Shortage Plan for the City of Santa Barbara demonstrates how outdoor residential watering restrictions can be made more severe as a drought situation progresses. During Phase 1 and 2 (minimum water shortage), existing residential landscaping could only be irrigated before 8 a.m. and after 5 p.m. During Phase III (severe water shortage) the use of sprinklers was banned and regulations allowed only drip irrigation.
- 2. Watering only with hand-held hose or container: In March 1990, the City of Santa Barbara instituted a sprinkler ban whereby residential customers could only utilize drip irrigation. Sprinkler bans can create considerable public resentment because of the great inconveniences they cause. Fixed allocations, allowing customers to

responsibly use the water they are allocated as they see fit, allow the water purveyor to avoid unpopular water use bans until Phase 4. For example, the North Marin County Water District greatly exceeded their rationing goal of 30 percent with their sprinkler ban. They subsequently changed the plan to a voluntary percentage reduction program. A rationing level of 30 percent was achieved through that modification, eliminating most of the turf damage that would have occurred if the sprinkler ban had been continued.

- 3. Watering only with recycled water: Lawn watering was prohibited in Corpus Christi, Texas on August 25, 1984, as a result of the serious drought. The city implemented a program to use reclaimed water for landscape irrigation and construction uses. Licensed, private tank truck companies delivered reclaimed water to business and residential customers. Before implementing this program, the public health aspects were addressed by the local public health agency. Regulations stipulated that a minimum 1 part per million chlorine residual be maintained to all applied reclaimed water. This reclamation program was judged to be very successful both for reducing landscaping losses and for maintaining jobs and income of severely affected nursery and landscape businesses. This program provided an estimated 7 million gallons of reclaimed water for residential and business landscaping throughout the City during the months of August through October 1984.
- 4. Watering only with graywater: During 1989 Santa Barbara County amended the Building Code Ordinance to allow the use of graywater and in 1990 the County of San Luis Obispo adopted similar regulations. Most single-family residences produce 20 to 40 gallons of gray water per person each day. The per capita graywater produced at a residence is enough to provide all the water needs of four mature fruit trees or a dozen shrubs. The gray water is distributed through irrigation hose to subsurface irrigation points.

The Denver, Colorado, Drought Response Plan has a thoughtful approach to the use and timing of water use restrictions. Denver Water's goal for drought response is to preserve the quality of public life and economic activity to the extent possible in the face of water shortage. In 2002, the Board adopted policy guidelines for developing a drought restriction program. Denver Water will follow these principles in restricting water use during a drought.

- Avoid irretrievable loss of natural resources.
- Allow watering of irreplaceable trees.
- Avoid killing perennial landscaping if possible.
- Tailor water restrictions as much as possible to known landscape needs.
- Restrict less essential uses before essential uses.
- Restrict water use for misters, fountains and other aesthetic water features first.
- Avoid using water as a substitute for something else (for example, cleaning impervious surfaces or washing personal vehicles).
- Curtail outdoor water use (except for watering trees and shrubs), along with restrictions on commercial use, before restricting domestic indoor use.

- Affect individuals or small groups before affecting large groups or the public as a whole, allowing as much public activity as possible to be unaffected.
- Preserve community pools rather than residential pools.
- Restrict golf courses before public parks.
- Restrict water use on less heavily used areas of parks where grass can go dormant before restricting use on formal and informal playing fields, where recreational activity would either kill the grass or have to be prohibited.

Minimize adverse financial effects.

- Try not to put people out of business, although businesses that depend on purely discretionary water use will be affected.
- Restrict seasonal commercial use, which is likely to be outdoors.
- Restrict nonessential uses of water in businesses before affecting fundamental business functions.
- Work with large-volume water users to reduce use in the least disruptive manner.
- Engage in ongoing dialogue with the green industry to obtain input and allow these businesses to plan for future months.

Eliminate waste.

- Enforce restrictions and permit limitations in an effective manner.
- Adopt restrictive criteria for exemptions from restrictions.
- Discourage or prohibit irrigation of medians.
- Prohibit installation of new landscaping if its survival next season is in doubt.
- Develop incentive programs to promote savings.
- Perform audits to identify water waste and recommend solutions.
- Adopt extensive public information and media relations programs.
- Inform customers about the problems caused by drought and what they can do to help.
- Hold and attend public meetings as necessary to receive input.

The basic response to a Stage 1 Drought is voluntary measures; to a Stage 2 Drought, mandatory restrictions; to a Stage 3 Drought, a general prohibition on lawn watering; and to a Stage 4 Drought, rationing of water supplies for essential uses. Because Stage 2, Stage 3 and Stage 4 Drought restrictions are mandatory, they must be incorporated into Denver Water's Operating Rules, where they become enforceable pursuant to the Denver Charter, the Denver Revised Municipal Code and provisions in Denver Water's water service agreements and water leases.

Possible water restrictions are noted below. The nature of the restrictions used will depend on the severity and timing of the situation:

- Prohibit irrigation during the warmest hours of the day, for example between 10:00 a.m. and 7:00 p.m.
- Limit all sprinkler irrigation to a specific number of days per week or per month. This choice will depend on target consumption goals, the time of year and the extent to which irrigation is occurring, and how much demands have already decreased. For example, if demand has already been reduced by 15 percent

through other measures, limiting sprinkler irrigation during July and August to **two** days a week could further reduce average daily demand by as much as 5 percent. Limiting lawn or turf watering to one day a week could reduce average daily demand by as much 10 percent.

Sample schedules include:

- o Twice weekly
 - For Residential addresses ending in odd numbers: Saturday and Tuesday;
 - For Residential addresses ending in even numbers: Sunday and Thursday;
 - For commercial accounts: Monday and Friday; Wednesday: no outdoor irrigation with sprinklers.
- Once Weekly
 - For addresses ending with:
 - 0 or 1: Monday;
 - 2 or 3: Tuesday;
 - 4 or 5: Wednesday;
 - 6 or 7: Thursday;
 - 8 or 9: Friday;
 - Saturday and Sunday: No irrigation with sprinklers.
- Ban sprinkler irrigation, with low-volume irrigation prohibited during the warmest hours of the day, for example, between 10 a.m. and 7 p.m.

Possible Exemptions from Water Use Restrictions

- Categories of possible exemptions include: new lawns, new landscapes, sport fields and golf courses, ball fields and play fields.
- The use of non-potable water for street cleaning, dust control at construction sites and other non-potable uses are unlikely to be restricted.

Pricing

California law requires that water suppliers provide an analysis of the anticipated revenue impacts of reduced sales during shortages. Well-designed rate structures can reduce the potential financial impacts of water shortages.

Water suppliers can implement new water pricing structures during water shortages. In metered areas raising rates on the quantity used will result in water use reductions. A

water supplier can expect rapid and significant water use reductions to result from large per billing unit price increases. Combining a large billing unit price increase with significant excess use charges can guarantee that the targeted reduction is achieved. Devise water rates to enable the supplier to recover its purchase, treatment, and delivery costs as well as the additional costs related to the water shortage response program and replenishing the drought emergency fund.

Make pricing changes a part of a WSCP and adopt them as part of the plan. This can reduce the rate change approval process from months to weeks.

Inclining Block Rate

The billing rate increases as water use increases under an inclining block rate structure. This encourages customers to save water and frugal water users will benefit from lowered rates.

During water shortages make the steps between blocks very steep to strongly discourage excess use. In 1987, the Goleta Water District replaced its two-tier block rate structure with a four-tier inclining block rate structure. Tier four was \$2.25 per hundred cubic feet (HCF). During rationing this rate structure was accompanied by an excess-use charge of four times the highest tier (\$9 per HCF) for customers who exceeded their allotment (see the section on excess-use charges below).

Include a lifeline rate in the pricing system that is as low as possible for basic health and safety uses.

Seasonal Rates

For seasonal rates, low water charges cover the water production costs in winter; in summer, or other peak periods, the rates increase to meet the capital costs associated with the expanded facilities necessary to produce peak demand capacity. These increased summer rates influence customers to reduce water use to lower their costly summer water bills. The Los Angeles Department of Water and Power has a seasonal rate structure.

Uniform Rate

The same rate is charged for each billing unit consumed. While this method provides some incentive to reduce consumption it represents a passive rate structure that is not likely to reduce water sufficiently during a drought.

Drought Surcharge

During extreme water shortages, water utilities often institute surcharges to alleviate falling revenues due to decreased water sales. Make it clear that these surcharges are separate from normal billing, and will be eliminated when the drought ends.

Excess-Use Charge

This water fee is assessed during rationing periods to those customers exceeding their allotments. During the serious 1984 Texas drought, Corpus Christi officials implemented stiff excess use charges: \$3.00 for the first 1,000 gallons over the allotment; \$5.00 for the next 1,000 gallons; \$10.00 for the next 1,000 gallons; and, finally, \$25 for each additional 1,000 gallons.

Denver Water developed the following drought pricing principles.

There is a relationship between price and demand. In theory, customers respond to an increase in price by reducing demand. The question is at what price level will the customer respond? The answer varies based on a number of factors.

Surcharges will be incorporated into an overall program to increase customer awareness of the drought's severity and the importance of saving water. Customers respond to the "basket of programs" concept, which includes surcharges. Drought pricing plays a role in creating an environment in which customers recognize the importance of reducing water use.

Surcharges may apply to current water demands, new taps, or other demands on the water supply. There is concern about issuing new taps when existing customers are subject to surcharges. Applying various forms of surcharges to different types of demands on the water supply provides an equitable method allowing all customers to share the burden of the reduced supply.

Surcharges are less effective by themselves. Industry studies and Denver Water's own customer surveys indicate that surcharges are more effective at reducing water use when combined with other restrictions to create an atmosphere that promotes water savings. Customer response to price signals varies depending on several factors such as affluence, billing frequency, and the normal cost of water. Empirical data show that customers respond to temporary water pricing strategies as part of a water savings environment.

Surcharges are separate from rates. Rates are based on cost. They are established to recover particular kinds of costs specified by the Denver City Charter. The purpose of drought surcharges, on the other hand, is to raise awareness of the value of water, to reduce water use, and to penalize those who don't comply with drought restrictions. These goals are better accomplished when surcharges are implemented as a temporary measure outside the cost-of-service rate structure.

Surcharges should match the severity of the drought. Because every drought is different, each one may require a different set of responses. Surcharges must be structured to help create an atmosphere of appropriate water savings.

Surcharges must be feasible for computer systems to handle. Denver Water must be able to respond to drought conditions quickly and efficiently. Any change in water use charges must be manageable with only moderate modifications to existing computer systems. Substantial changes increase response times and contribute to errors. Because internal coordination is critical, staff members from Customer Care, Information Technology, Accounting, and other relevant sections will be included in discussions of surcharge options.

Surcharges should be tailored for different customer groups and monitored for effect. A one-size surcharge does not fit all. Commercial and industrial customers use water differently

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from residential customers. Large-volume public use customers may need some accommodation. The surcharge structure must be flexible enough to promote water savings while still addressing diverse customer needs.

Surcharges should reflect overall drought response philosophies. Because all surcharge structures divide customers into groups, no surcharge structure is 100 percent "fair." Some customers may pay a surcharge even if they comply with the other restrictions. In addition to raising awareness of the value of water and encouraging temporary reductions in use, surcharges can supplement revenues if necessary.

Surcharges may need to be seasonally adjusted. In Colorado's semi-arid climate, water use is greater in summer than in winter. Outdoor use is more discretionary than indoor use, and surcharges should be adjusted to assist in maintaining a water savings environment. Because restrictions to reduce indoor use are difficult to design, adjusting surcharge thresholds can be more effective at monitoring and reducing indoor water demand in winter.

Public input and information are key to customer understanding of surcharges. When surcharges are designed and implemented, the public must have adequate opportunities for input, the surcharge must help create an atmosphere of water savings, and the public must receive adequate information to fully understand the surcharge program.

Surcharges are temporary measures. The criteria that determine when surcharges will be lifted should be specified before the surcharges are imposed. This will reinforce the temporary nature of the surcharge in the minds of customers.

Equity issues related to removing the surcharge should be addressed in advance. The specified conditions leading to termination of surcharges do not always occur at the end of a billing period. Criteria for lifting the surcharge once the specified conditions occur should be considered ahead of time.

Some water suppliers have programs to audit specific water uses. Recommendations are made on how much water is needed for the uses after reasonable conservation measures are implemented. The use of landscape water budgets, where a certain amount of water is allowed per square foot of landscape, is a good example. When rationing is required, these conservation-based amounts can provide the first block volumes. Water used beyond that can be priced more expensively to encourage the conservation actions.

Whenever price structure changes are contemplated for use as part of a water shortage management plan, a realistic assessment of the time and effort to complete the approval process is needed. Often, the utility rate setting process takes several months. However, declaring a water shortage emergency allows agencies to make immediate rate adjustments.

Also, it may be unrealistic to expect the conservation benefits of price changes to make an immediate impact, especially if billing cycles are staggered or are on a bimonthly basis. However, significant excess use charges, even where billing cycles were staggered or on a bimonthly basis, had an immediate and significant impact on demand during 1990 in San Luis Obispo, Santa Barbara and Ventura.

It is standard practice for water suppliers to maintain a dry year contingency reserve to protect revenue through two or more successive years of supply reductions below normal

demand levels. Rate hikes, surcharges, or borrowing strategies are anticipated in agencies without an established reserve or when the reserve has become depleted.

The East Bay Municipal Utility District (EBMUD) assesses its water availability and integrates the data into its financial planning and annual rate review for budget purposes. In the past, when mandatory use reductions were implemented based on this assessment, an inclining block rate structure was adopted as part of the water shortage management program, designed to encourage consumers to conserve water and to fully mitigate the revenue and expenditure impacts. In addition to offsetting the decrease in water sales, revenue recovery covers the extraordinary expenses of the water shortage management program. During the drought year of 1988, EBMUD budgeted \$1.8 million for this program.

Unmetered Suppliers and Pricing

Unmetered areas face special challenges implementing drought conservation programs because they cannot impose per customer reductions or per capita allotments. Conservation programs consist of informational programs, restrictions, voluntary measures using rebates and incentives, technical assistance. Appendix K presents suggested programs for agencies with unmetered residential accounts.

Rationing Allocations

Consumer response to rationing allocation programs is more predictable than to the other approaches, and these are generally the most effective programs to achieve significant demand reduction. As an example, Table 3 shows the broad range of conservation policies adopted by selected California water suppliers during the 1976-1977 drought and their results. In nearly every instance where mandatory rationing was implemented, consumers responded by reducing water use further than was requested.

A strict rationing program combined with a prohibition of landscape sprinkler irrigation can bring per capita water use down to low levels. The Marin Municipal Water District achieved a per capita use rate of 35 gallons per day in 1977.

In California, the California Public Utilities Commission regulates private water suppliers, also known as Investor Owned Utilities. They have established rules and procedures for regulated agencies regarding rationing and service connection moratorium. Their Instructions for Water Conservation, Rationing, and Service Connection Moratoria can be found in Appendix C.

Table 3 Programs Adopted by Retail Water Suppliers during California Drought 1976-77

Supplier	Residential Rationing Program	Achievement, percent
Marin Municipal Water District	Mandatory 57 percent per capita	65
East Bay Municipal Utility District	Mandatory 35 percent per household	40
Contra Costa County Water District	Mandatory 30 percent	25
San Francisco Water Department	Mandatory 25 percent	30
Los Angeles DWP	Mandatory 10 percent	16
Sunnyvale Water Department	Voluntary 25 percent	26
Santa Clara Valley Water District	Voluntary 25 percent	30
City of Pleasanton	No program	19

One of the inherent problems with a rationing system is in accurately designing the program to achieve the desired demand reduction level without greatly exceeding this amount. Although midcourse corrections can be made to lessen the impact of a program proving to be too severe, such adjustments are risky and most managers are reluctant to make them. Water officials feel that changing programs too often sends a message to the customers that the supplier's planning was faulty. Therefore, it is necessary that rationing program corrections be presented carefully to customers.

Key elements of a successful rationing program are that the available water is shared as equitably as possible, and that customers are kept informed about the status of the shortage. The California Water Code, Section 354 of Chapter 3, Appendix A, generally stipulates the establishment of priorities and allocations for purposes beyond basic domestic, sanitation, and fire protection uses. However, allocation disagreements are to be expected and procedures to handle valid exceptions and variances need to be part of every rationing program.

A good public information program facilitates administration and enforcement of a rationing plan. Publish and disseminate pertinent information regarding water use and supply at least weekly to continually maintain customer commitment. Also, providing fixture replacement rebates, customer water surveys and useful information to help customers reduce water consumption stimulates relatively painless short term and long term water demand reductions.

Rationing programs are generally patterned after one of five basic allocation schemes: (1) Percent Reduction, (2) Financial Rationing, (3) Per Connection Allotment, (4) Per Capita Allotment, (5) Hybrid Per Capita / Percentage. Percent reductions and financial rationing can be applied to all customer types. The other schemes are for residential customers only.

A percentage reduction assigns each customer a consumption reduction goal as a percentage of the consumption level used in a previous year or a five-year average. Required percent reductions can be constant, stepped, or variable. Fixed percentage reductions were widely implemented during the 1977 California drought. The cities of Concord, Palo Alto, San Mateo, Napa, and Vallejo all implemented allotment programs dependent upon a customer's previous year water use. In southern California, people were given a baseline allotment of 90 percent of their former year's consumption with excess use charges for water consumption above that level. The fixed percentage system was easy to coordinate because water allocations were quickly determined from the previous year's water bills. However, the percentage reduction method was widely perceived as inequitable because it had the effect of penalizing former water conservers while rewarding those who had previously used large water quantities. Identical houses could therefore receive vastly different water allotments. Also, this plan does not distinguish between indoor and outdoor water use.

During severe shortages a rationing plan based on percentage reductions may cause huge disparities in allotments between similar customers. This will create serious management problems for the water supplier because many requests for exemptions will be filed and many people will perceive the system to be unfair. In 1991 the City of San Francisco called for reductions of 90 and 33 percent in exterior and interior water use respectively. Inequity was minimized by limiting deliveries to 300 gallons per single family home per day, and 150 gallons per multifamily dwelling per day.

The *hybrid seasonal allotment* is similar to the percentage reduction except that the consumption reduction goal is varied depending on the time of year. Both of these methods inadvertently reward past wasteful behavior and penalize past conservation behavior by using previous demand levels in the computation of rationed allotments.

Financial rationing sets tiers based on past use for non-residential customers and the number of residents for residential customers. The advantage of this system is that the market determines how water is used and, because it avoids per customer allotments, it is easy for the supplier to implement. The community is unlikely to support this scheme because it relates water use to income and there is no sense of equity. Since non-residential tiers are based on historic use it rewards high-water users and penalizes efficient customers. The supplier sets residential tiers based on average number of occupants, and this results in a large number of appeals. Generally, the negatives outweigh the positives.

Per Connection allotment (residential only) establishes a customer's water consumption goal on a unit basis (such as the number of bedrooms per single family home or multifamily unit) calculated from an estimate of essential uses. A per connection basis is easier to determine than a per capita basis, but may introduce unfair allocations because there is no relations between historic use, customer characteristics, or how many people reside at the residence.

Per Capita allotment (residential only) provides a fixed amount of water per person. San Francisco area residents in an attitude survey conducted after the 1976-77 drought

preferred this rationing method. Marin County's plan with per capita allotments was judged fairest, however it basically banned outside irrigation. This program achieved a 63.1 percent reduction compared to 1975 (pre-drought) consumption patterns. Apartment dwellers cut back their water use by an average of 45 percent and single-family homes reduced water use 75 percent. This method results in significant work for agency staff, both in determining the number of residents per home and in changing allotments as the number of residents per home changes. It is difficult to equitably provide allocations for other than essential inside use.

Hybrid per capita / percentage allotment programs have allowed limited outside irrigation, distinguished between single family and multifamily dwellings with different water use requirements and still produced 35 to 45 percent reductions. Customers generally prefer a fixed allocation within which they can determine their own water use priorities. The hybrid provides water for inside use and a percentage of the five-year average outside use. GIS systems now allow the outside use portion of the hybrid system to be based on the landscaped area served by each meter. However, a maximum per customer allocation is necessary in order to limit the amount of water allocated to large parcels. Otherwise the community may not see the allocation method as equitable.

The Goleta Water District's rationing plan established a *hybrid fixed per capita and percentage reduction* for residential accounts. Each residential account received a life-line allocation (11 HCF/month single family [69 gpcd], 7 HCF/month multi-residential unit [58 gpcd]) and a percentage of its average use. Reductions ranged from 0 percent for the most conservative users to 45 percent for the largest users. If the water shortage increases the percentage add-on can be reduced or eliminated.

Residential allocations were increased for additional residents at the service, health related problems and fruit trees, but only if efficient toilets and showerheads and drip irrigation were installed at the account. Commercial accounts were reduced by a percentage from their five-year average. Agricultural accounts were provided with enough water to keep permanent crops (orchards) alive but not enough to produce full yields.

This program was implemented in May 1989 with a systematic goal of 15 percent conservation and achieved a 30 percent reduction. When the drought intensified during the winter of 1990, even with allocations staying the same, residential accounts reduced use by 50 percent with a district-wide reduction of 36 percent below the 1984-88 average.

The type of rationing method selected depends on three factors: (1) the amount of water available for health, safety and sanitary purposes, commercial/industrial uses, agriculture and landscape irrigation; (2) the seasonal variation in water consumption (usually a function of irrigation demand): and (3) the degree of homogeneity among consumer types. Where water is in extremely short supply and no water is available for irrigation, the fixed allotment approach usually works best. Where some water is available for landscape irrigation, a plan that permits the customer more water in the dry season, a hybrid per capita basis is preferable.

In general, restrictions prohibiting specific consumer actions (such as a total ban on sprinkler usage or car washing) are less popular and harder to enforce than those

providing customers with an allocated amount. Reserve absolute restrictions for cases of extreme shortage.

When rationing is in effect water suppliers may want to make special efforts to help customers save trees in their landscapes. Mature trees take longer to establish than smaller landscape plants, and their value is greater. Trees also provide shading, cooling, and help to keep the air cleaner. If the water supplier permits some landscape irrigation, customers may be advised to irrigate trees because they are the most valuable component of the landscape. Even if no landscape irrigation is permitted, customers might be advised to use graywater to keep trees alive.

Enforcement

During extreme shortages, a call for voluntary conservation may not bring sufficient reduction of water use, especially where water consumption is to be reduced by more than 20 percent. In such cases it may be necessary to institute mandatory conservation measures (such as rationing), enforceable under the authority of special ordinances or revised rate schedules. Table 4 summarizes penalties that can be used to enforce such programs. The most severe violations may call for discontinuance of service. Less extreme infractions may be handled with a rate schedule that imposes financial penalties for excess use.

Education, citations and fines

Many water suppliers have noted that the availability of enforcement mechanisms is the most important feature, and that application of enforcement procedures is rare. Nevertheless, it is important that customers know that those who choose not to cooperate will be dealt with firmly. This way, the consumer is assured that the program is uniformly applied and fair to all. Communicate the supplier's resolve in this regard at the very start of the program.

A common enforcement program is to use water waste patrols, frequently referred to as "water cops." These generally issue warnings for the first one or two violations. Subsequent violations are subject to fines and, if still uncorrected, installation of water flow restrictors on the service to the customer. Water cops (drought monitors) enforce the water shortage restrictions and water waste rules. The goal of water cops is to use education to help customers save water, not merely to penalize violators.

Restrictions on the days when landscape irrigation are allowed have not always been successful. Some residents water on the designated days regardless of whether the landscape needs the water. Others over irrigate their landscapes in the hope the water will last longer. This overuse cannot be controlled by patrols.

Landscape irrigation run-off is easily detected by the water patrols when it occurs on front lawns and public and business landscapes. The value of these patrols is to help customers understand and operate their irrigation systems. The patrols are also a visible reminder to the community of the seriousness of the situation.

Patrols are particularly necessary when there are restrictions on the time-of-day when landscape irrigation is allowed. Schedule the patrols to do a lot of their patrolling in the evenings and early mornings. Restrictions on daytime watering mean that many residents with automatic sprinklers will schedule watering for when they are asleep. Photos or video made during evening or early morning patrols have been a useful tool to demonstrate to property managers and non-residential property owners that their irrigation systems need repair or adjustment.

Monitoring customers for compliance with mandatory measures that are not strictly consumption related is a complex issue. Most water suppliers rely heavily on peer group pressure and observations by the public and by water supplier field employees during their regular work schedule. Also, city or county employees, whose daily routine work requires them to be moving about the community, can be empowered to issue citations, although these employees are often reluctant to fulfill this role. Such types of employees include supervisors of street and wastewater departments and inspectors for building, plumbing, electrical, construction and health services. This is an effective method of covering the service area at minimum expense and with little interruption of the employee's regular duties. Police are not widely used unless there is a problem with a specific customer.

Table 4 Examples of Drought/ Emergency Conservation Plan Penalties

Violation	Penalty								
Occurrence	Prohibited use	Excess use							
First	Written warning via regular mail.	Written warning via regular mail.							
Second	Written warning delivered by utility representative who will offer conservation tips and approved retrofit devices.	Surcharge if allotment is exceeded. Written warning delivered by utility representative who will offer conservation tips and approved retrofit devices.							
Third	Flow restrictor (1 gpm [4 L/min]) installed for 48 hours, installation and removal charges assessed.	Surcharge if allotment is exceeded. Flow restrictor (1 gpm [4 L/min]) installed for 48 hours, installation and removal charges assessed.							
Additional	Shutoff, plus reconnection charge of \$25.	Surcharge if allotment is exceeded. Shutoff, plus reconnection charge of \$25.							

Some jurisdictions provide an appeal process for customers and some offer alternative to fines that include water conservation classes, interior and exterior water use efficiency retrofits, and the application of fees to a professional landscape evaluation and water audit.

Citations issued by the City of Corpus Christi, Texas,

http://www.cctexas.com/?fuseaction=main.view&page=612, for violations of the water conservation ordinance represent a misdemeanor charge, punishable by a fine not to exceed \$200. The San Antonio, Texas www.saws.org/conservation/, water conservation plan provides for a special team of civilian field investigators to enforce the drought response ordinance when the highest-level drought stage is reached. These field investigators will be drawn from the fire, building, health, waste water, public works, and planning departments. Investigators will be empowered to issue both warning and regular citations to violators. Enforcement powers needed by a water supplier should be clearly described in drought ordinances.

Customer hotlines have also been a useful tool for identifying repeat violators. Such hotline reports can be web-linked as well, and can be integrated with the agency's work order system to issue a job for a monitoring official to visit the reported address of violation to issue a warning, or citation as necessary. Such hotlines greatly assist the agency's credibility in enforcement, if reported violations are quickly followed up by enforcement. One drawback reported is that some neighborly feuds duel repeated calls to hotlines, and the agency staff will have to identify such patterns, and eliminate responding to calls where no violations are observed. Despite this perceived drawback, the reduced time to address violations due to public reporting is a benefit to enforcement programs.

Flow Restrictors

Some customers will continue to exceed their allotment regardless of the size of their water bill. Even one customer that refuses to support the community's efforts to reduce water use can undermine the essential community belief in equity. At some point the media will contact water suppliers with a request for information on customers with the greatest water use or largest bills. Suppliers have the legal authority to enforce drought regulations by terminating service. Most suppliers have instead chosen to install flow restrictors on non-cooperative customers. Flow restrictors can be manufactured by the supplier to provide, for instance, a one gallon-per-minute flow—allowing only enough water for health and safety needs.

Measures

Demand reduction measures for existing customers seek to reduce water use through plumbing fixture replacement, fixture leak detection and repair, water audits to reveal alternative ways of using water, improve landscape irrigation practices, and use restrictions specific to the customer class. There are many sources of information regarding water conservation measures. The California Urban Water Council's Web site: www.cuwcc.org is a key source of information about urban water management practices. State and federal agencies listed in Appendix F are also good sources of water conservation information.

Establish or expand existing toilet and showerhead replacement programs. While replacement is normally performed for long-term conservation, it can be implemented quickly if enough financial and human resources are allocated.

Homes without efficient devices have an average of 28 gallons per capita per day (gpcd) indoor use more than water-efficient homes (i.e., 62 gpcd vs. 34 gpcd, respectively). A replacement campaign reduces consumption in these less efficient homes by providing efficient showerheads, dye tablets to identify leaky toilets and offering toilet, clothes washer, irrigation timer and other rebates.

Some water suppliers offer incentives to replace turf as part of their ongoing conservation programs, and this can be expanded and focused on artificial turf or replacement landscaping when the shortage ends.

During moderate supply shortages, demand reduction methods can be incorporated as part of the requirements for new connections to the water system. Alternatively, new customers can be actively encouraged to voluntarily adopt demand reduction measures with a connection fee discount. The public information program covers both new and existing customers. During severe and critical supply shortages, deferment of landscape installations in new development is justifiable.

A ban on new connections during critical shortages is something water suppliers will be asked to consider by its existing customers. Because already permitted construction projects will continue for many months, the short term economic impacts on the construction trades could be minimal. If the shortage persists for longer time periods, the demand resulting from new connections approved during the critical shortage could result in severe economic harm to existing customers.

A way to deal equitably with the new connection issue that can be especially effective in water shortages is to enact a demand-offset program. Under this program, developers wanting approval for new construction are required to demonstrate that they will conserve at least as much water in the community as their new project will use.

Developers have the option to carry out the conservation themselves or they can contribute a specified amount into the water supplier's conservation fund. These funds can then be used to finance conservation improvements in public facilities, low-income housing or expand customer rebate programs. This has the double benefit of conserving water and providing assistance to low-income residents or the whole community.

A one-to-one offset still puts the existing community at a disadvantage. When the project is completed there is still an increased demand on the supply. Although the developer has offset the new demand, this has been accomplished by using up some of the existing slack in the community's existing water use practices. When the next drought comes there is less slack and the new development, which is already water efficient, will result in increased demand.

This can be compensated for by having a greater than one-to-one offset. The developer would fund conservation of more water than the amount the new project would use. This

would mean that the new project would actually make the community better able to resist a water shortage. Santa Monica has required a two-to-one offset.

Table 5 Demand Reduction Techniques

l able 5	Demand Reduction Techniques
Customer Category	Examples
Existing Residential	1. Interior
	a. Public Information
	b. Residential water audit
	c. Fixture leak detection and repair
	d. Plumbing fixture replacement
	e. Appliance replacement
	2. Exterior
	a. Public Information
	b. Landscape water audit
	c. Turf irrigation guidelines / Irrigation timer settings
	d. Pool covers & refill restrictions, hose nozzles
	e. Landscape irrigation improvements & repair
	f. Use restrictions (day or time of use)
	g. Graywater use guidelines
Existing Commercial and	Employee information programs
Institutional	2. Interior water use audits
	3. Landscape irrigation audits
	4. Plumbing fixture repair and replacement
	5. Irrigation system repair and improvement
	6. Specific use restrictions
Existing Industrial	Employee information programs
	2. Interior water use audits
	3. Landscape irrigation audits
	4. Plumbing fixture repair and replacement
	5. Irrigation system repair and improvement
	6. Process water audits
	7. Process system repair and improvement
	8. Specific use restrictions
New Connections	1. Information program
	2. Plumbing code changes
	3. Restrictions on new landscaping
	4. Pool filling restrictions
	5. No new landscaping
	6. Connection moratorium

Mandatory compliance measures are more severe than voluntary measures and produce greater water savings. The principal drawback to these measures is customer resentment if the measures are not seen as equitable. Therefore, design the mandatory measures well and accompany them with a good public relations campaign. Convince customers that their sacrifices are warranted. Show them that the water supplier is achieving a balance between demand and available supply.

Three methods of demand reduction exist which are generally imposed to affect all customer classes – Restrictions on water-use practices, price restructuring, and rationing (limits on customer water-use).

Customer Feedback

In order for customers to know how they are doing in meeting their conservation requirements, provide customers with simple instructions on how to read their meters and to convert billing units to gallons.

Print a comparison of actual water use with allocation on the bills. Also, print the customer's allocation for the next billing period on the bill. If the customer has a yearly allocation, provide information on the year-to-date use on the bill.

STEP 4: Establish Triggering Levels

Identify the specific supply shortage that will "trigger" each of the water shortage plan stages. Then, in Step 5, with deficit reduction targets quantified, the appropriate water-saving measures can be selected for the demand reduction program. Triggers can include such indicators as: water quality changes, supply interruptions, environmental changes and regional agreements.

Trigger Mechanisms

Define Trigger Mechanisms

Comparison of forecasted supply and demand provides the basis for implementing or intensifying a water shortage emergency. The number of supply sources and the degree of uncertainty affecting the reliability of each source determines the complexity of the water shortage triggers. A relatively simple scheme, which the City of Denver, Colorado has adopted, is illustrated in Table 6. In this case, measurement of the water level of the reservoirs (expressed as a percent of normal seasonal capacity) gives sufficient indication of drought status in a community primarily dependent on surface water.

Table 6 City of Denver, May 2004 Drought Response Plan - Stage Criteria

Reservoir Storage >	Drought Stage Declared	Water Use Reduction Goal
80%	Stage 1	10%
65%	Stage 2	30%
40%	Stage 3	50%
25%	Stage 4	66%

The threshold for declaring a drought - reservoir storage at 80 percent - was chosen for two reasons. The first reason: 80 percent is the amount of water that, with increasingly cautious use over time, is projected to see Denver Water's existing customers through a drought more severe than they experienced in the 1950s. The second reason is to avoid inconveniencing customers more often than necessary. As growth occurs or firm yield estimates change, this threshold may need to be changed.

A sliding scale for trigger values is often represented graphically. In the drought contingency plan for the Delaware River Basin, several stages of diversions, reservoir releases, emergency reservoir operations, and conservation measures are keyed to four drought stage conditions. These conditions are determined from a set of operation curves based on the total remaining available storage in three reservoirs.

Causes of delaying implementing a Stage

There will be enormous pressure to NOT declare a water shortage. It is important that triggers be clearly defined and documented as part of the adopted water shortage plan.

Imposing restrictions, significant water rate increases or rationing on a community results in upset customers that foresee damage to their businesses, homes and lifestyles. Political leaders need clearly defined triggers to make decisions when there is a water supply problem. A world exposition and drought occurred in Seville, Spain in 1992 and the community used all of their reserve supplies to avoid announcing the water shortage. When the exposition ended the community had so little water left that it risked severe damage to the city's future.

Whatever parameters are used for trigger mechanisms, they must be ones that can be assessed on a frequent basis. Make the analysis of such information readily available to decision makers in a timely manner. Using such a quantified system, advancement through drought stages can be almost automatic. However, when complex trigger mechanisms are used, some uncertainty may arise as to whether or not to initiate a given drought stage. For example, reservoir levels are low but a water transfer is being negotiated. Assign the resolution of such 'gray area' decisions to a specific individual or group that is clearly responsible for making these difficult decisions. Let early demand reduction program implementation be the guiding rule, not "hoping for rain".

The Denver Water Department's Drought Response Plan addresses the tradeoffs associated with early versus delayed action in case of possible drought. Declaring a drought is similar to announcing a candidacy for political office: triggering the event requires considerable preparation and good timing. Based upon the existing triggering system, Denver estimates that its customers would have water use restrictions about 10 percent of the time. The Denver plan also discusses the impact of drought in terms of the effects on water supplies as well as society. Less tangible than the effects of drought on the water supply are the societal, economic, environmental, and political impacts, including relations with surrounding communities. These issues, Denver contends, are important factors to consider (www.denverwater.org).

Denver Water staff spent a great deal of time analyzing and debating the advantages and disadvantages of taking early action in response to a possible drought versus delaying action until drought conditions are more clear. Tradeoffs are shown in Table 7.

Table 7 City of Denver, May 2004 Drought Response Plan – Early Versus Delayed Implementation

Early Action	Delayed Action
Customers are frequently asked or required to reduce water use.	Customers are infrequently asked or required to reduce water use.
Reservoirs stay relatively full.	Reservoirs are less full.
A severe drought can be withstood before storage water runs out.	A less severe drought can be withstood before storage water runs out.

A primary focus in the debate over early action versus delayed action is the potential hardship caused by reducing water use versus drawing down reservoir storage. Reducing water use could affect businesses and damage water-thirsty landscapes. Low reservoirs reduce or prevent recreation, stress the environment, create aesthetic problems and put the community at risk. Denver Water staff proposed storage levels and drought responses on the basis of three questions:

- How severe a drought could Denver Water withstand with a range of potential storage levels?
- With these storage levels, how often and how much would customers be asked to reduce water use?
- How low would storage levels get?

Alternatively, a weighted indicator may be derived from the combination of all relevant factors. The latter method is used in the drought contingency plan for the Delaware River Basin which relies on five drought indicators: precipitation, groundwater levels, reservoir storage stream flow, and the Palmer Drought Severity Index, a standard meteorological classification of moisture conditions, from extremely wet (4.00) to extreme drought (-0.400). Ranges of values for each of these parameters are assigned to one of four drought stages (normal, drought watch, drought warning, and drought emergency). In order for a given drought stage to commence, three of the five drought parameters must indicate a given stage. During winter months, if the Palmer Index and stream flow indicators are judged unreliable, then any two of the three remaining drought indicators will trigger a given drought stage.

Include flexibility

Correlate the number of successive levels of drought stages with a series of realistic deficit reduction goals. Most communities have used between three and five stages. Fewer than three stages require dramatic changes between the first and second stages of plan implementation. Greater than five stages may incur frequent transitions which could reduce the effectiveness of deficit reduction measures as they are introduced. However, recent experience indicates that water suppliers often delay imposing more restrictive stages and thus stage five is often implemented within a few weeks or months of stage three - a definite breakdown in the implementation process.

Deficit reduction objectives for each drought stage are commonly expressed as a percentage of average demand levels or as a quantity of water saved. Tables 6 show goals established for Manchester, Connecticut.

Table 8 Manchester, Connecticut Drought Contingency Plan

Drought Phase	Water Supply Available	Action
Alert	80 percent of reservoir capacity	Closely monitor reservoir capacities and implement resource management plan. The water capacity is brought to the attention of the citizens through press releases.
Advisory	70 percent of reservoir capacity	Follow the water resource management plan and requests voluntary conservation measures on the part of the citizens (usually outdoor water use).
Emergency Phase 1	60 percent of reservoir capacity	Mandatory use restrictions (typically a ban on outdoor water use - a 10 percent reduction).
Emergency Phase 2	40 percent of reservoir capacity	Mandatory 10 percent reduction in indoor water use. All outdoor water use is banned. A public relations campaign is initiated to identify methods to accomplish the required reductions (total use reduction 20 percent). Enforcement actions will be taken.
Emergency Phase 3	30 percent of reservoir capacity	Mandatory 20 percent reduction in indoor water use. Outdoor use banned. Overall minimum 30 percent use reduction is required. Additional mandatory reductions in indoor water use may be required based upon continued reductions in reservoir levels. Enforcement actions will be taken.

The setting of realistic goals includes correct timing in instituting demand reduction efforts that are neither under nor overly conservative in light of the drought situation at hand. While curtailment of water use results in economic impacts on the water supplier as well as the customer, failure to curtail water use when necessary may result in much greater economic impacts later. Establishing appropriate levels of deficit reduction is important in terms of sustaining consumer support of voluntary and mandatory measures.

The Seattle Plan establishes the following criteria for curtailments during a water shortage.

Criteria for Curtailment during a Water Shortage

There are several criteria for deciding which curtailment measures are appropriate to reduce demand during a water shortage:

- Timing: Can the measures or actions produce results in the necessary timeframe?
- Magnitude of savings: Will the measures or actions result in enough savings to make a meaningful difference(i.e., reduce demand to the level the impaired water system can handle?).
- Season: Are the actions or measures relevant to the time of year (i.e., banning lawn watering during the summer irrigation season vs. during non-irrigation season?).
- Costs: How severe are the cost implications of the measure to the customer, including local business and industry, relative to the need for action? Note: While there could be costs to certain customers, particular actions still may be necessary for public health and safety reasons.

Exit Strategy for WSCP Stages (Seattle)

As soon as actual and forecasted supply conditions substantially improve, Seattle Public Utilities will either inform the public of the return to normal use of water, or inform them that the utility is moving from one stage to a lesser stage of this plan. This latter process would occur until there was a return to normal operations. Stages could be skipped in this process as conditions and forecasts warrant.

STEP 5: Develop a Staged Demand Reduction Program

Identify the demand management actions that will be used in each stage to produce the necessary water savings. Supply augmentation is not considered in this step. Supply was considered in Step 4 when the water shortage stage triggers were developed. In this step, demand management actions are correlated with customer water-use characteristics and the projected savings are quantified. Program design is evaluated for effectiveness, timeliness, and cost.

Establish Stages

The best approach to managing water demand during a water shortage is to use a staged approach, with increasing levels of savings in each successive phase. A typical staged reduction is shown in the Table 9:

lable	Example Stage	es with Demand Neduction Goals
Stage	Water Shortage	Demand reduction goal - %
1	Minimum	10 to 15
2	Moderate	15 to 25
3	Severe	25 to 40
4	Critical	40+

Table 9 Example Stages with Demand Reduction Goals

Prepare a description of the specific measures in each stage as is shown in Table 9. This list is a general guide. The actual plan developed by a water supplier may differ depending on local circumstances.

Stage 1 relies primarily upon voluntary action by the water consumers. These actions are taken in anticipation of the drought continuing and the community benefiting from increased carryover. Subsequent stages are in response to increasing supply shortages. Stage 2 utilizes some mandatory measures and Stages 3 and 4 involve water rationing. Stage 4 includes extensive restrictions on water use and would be initiated only in extreme circumstances.

The estimated percent water use reduction in the model plan for each drought stage was derived from savings achieved in previous drought situations by comparable water shortage management plans. The typical demand reduction goals for staged plans normally range from 5 to 10 percent in the first stage to as much as 50 percent in the last stage. Stage 4 in the model program could achieve more than 50 percent savings by further reducing the per capita water allotment contained in the model plan. However, community hardship increases above 35 percent. For example, most communities facing a 50 percent cutback could save, by using graywater, valuable trees and shrubs but most turf would go dormant and some may die. Lawns are less expensive and easier to replace than mature trees and shrubs.

Contra Costa Water District, WSCP, Example Reduction Goals

Sample customer class reduction goals under the various supply shortage stages are shown in Table 4-2. These allotments are provided as an example of how to achieve the overall desired reduction goal while acknowledging the constraints various customer classes may have in effecting short-term demand reduction. Alternative allocations may be considered at the time a given stage is implemented. The Board of Directors has recognized in the past that industrial customers cannot sustain the same percentage cutback as municipal customers without severe economic hardship. Therefore, it is proposed to keep reductions to industrial customers to less than 10 percent, and in most cases to have a goal of no more than 5 percent. It was also recognized that multifamily residential water users have primarily indoor water use and cannot reduce their water use as much as the single-family residences, which typically have nearly half of their water, use as outdoor uses. The use of increments of five in choosing the reduction goals facilitates CCWD in communicating its reduction goals to its customers.

Stage IV ⁽⁶⁾ 35-50% ⁽⁶⁾	Stage II Stage III Stage			e I Stage II Stage III ^(b) 10-20% ^(a) 20-35% ^(a)		Stage I -10% ^(a)		% of			
Sales	Goal (%)	Goal (%	Sales (AF)	Goal (%)	Sales (AF)	Goal (%)	Sales (AF)	Goal (%)	Total Sales	2004 Sales (AF)	Water Use Sectors
										ice Area	Raw Water Servi
40% 28,460	40%	40	35,576	25%	40,319	15%	45,062	5%	39%	47,434	Municipal
10% 29,930	10%	10	31,592	5%	31,592	5%	33,255	0%	27%	33,255	Industrial
90% 161	90%	90	403	75%	1,128	30%	1,451	10%	1%	1,612	Irrigation
40% 110	40%	40	138	25%	156	15%	175	5%	0%	184	Agriculture
58,661			67,709		73,195		79,943		68%	82,485	Subtotal
										ervice Area	Treated Water S
45% 12,130	45%	45	15,438	30%	17,643	20%	20,951	5%	18%	22,054	SF Residential
40% 3,795	40%	40	4,744	25%	5,376	15%	6,009	5%	5%	6,325	MF Residential
90% 444	90%	90	1,111	75%	3,110	30%	3,999	10%	4%	4,443	Irrigation
30% 3,001	30%	30	3,430	20%	3,858	10%	4,073	5%	4%	4,287	Commercial
10% 222	10%	10	235	5%	235	5%	247	0%	0.2%	247	Industrial
30% 690	30%	30	788	20%	887	10%	936	5%	1%	985	Public Authority
0% 137	0%	0	137	0%	137	0%	137	0%	0.1%	137	Private Fire Protection
100% 0	100%	100	0	100%	76	0%	76	0%	0.1%	76	Temporary Service
40% 37	40%	40	47	25%	53	15%	59	5%	0.1%	62	Municipal
20,456			25,930		31,375		36,487		32%	38,616	Subtotal
	40	40	47	100.0	53		59		0.1%	62	Municipal

⁽a) Range in overall reduction goal to be achieved for a given supply reduction stage. A stage's overall reduction goal equals the water supply shortage remaining after supplemental supplies are obtained.

⁽b) The Urban Water Management Planning Act requires the Plan to consider the reductions necessary to achieve a maximum reduction of 50 percent. Stages III and IV are not expected to be experienced as a result of drought, but rather in response to an emergency situation and exceeds CCWD's estimate of the minimum public health and safety requirement.

Evaluate Demand Reduction Measures

Once water shortage demand reduction measures are identified, generate certain information to provide decision makers with a rational basis to review and select appropriate measures that will be used in the plan. Basic considerations include:

- Water savings.
- Lead time required to activate measure.
- Direct and indirect costs.
- Legal or procedural requirements for implementation.

The Florida Drought Action Plan, April 2007, used a matrix to evaluate demand reduction programs on several important factors.

Attachment 5: Summary of Recommendations of the April 2002 Water Conservation Initiative by Work Group Area

The 2002 Water Conservation Initiative resulted in fifty-one separate recommendations for increased water use efficiency. Many of the recommendations have been implemented in the Conserve Florida Program (section 373.227, F.S.,) the Landscape Irrigation and Florida-Friendly Design Committee (section 373.228, F.S.), the Water Protection and Sustainability Program (sections 403.890 and 373.1961, F.S.), and other programs. However, there are still many recommendations made in response to the last major Florida drought that have not yet been fully implemented and should be reconsidered.

Recommended Water Conservation Alternatives³

Water Conservation Alternative	Priority	Total Score	An	nount (of Wa		ved	tiver	-Effectiess	men	of Imple- ting (1 to 3) ⁶
Agricultural Irrigation											
AI-1: Cost share and other incentives	High	10	٠	٠	٠	٠	٠	S	\$	\$ ✓	✓
AI-2: More mobile irrigation labs to achieve water conservation BMPs	High	10	٠	٠	٠	٠	٠	S	\$	\$ ✓	✓
AI-3: Increase rainfall harvesting and recycling of irrigation water	High	9	٠	٠	٠	٠	٠	S	\$	\$ ✓	
AI-4: Increase the reuse of reclaimed water	High	9	٠	٠	٠	٠	٠	S	\$	\$ ✓	
AI-5: Improve methods for measuring water use and estimating agricultural water needs	Medium	8	٠	٠	٠	٠		S	\$	✓	✓
AI-6: Conduct additional research to improve agricultural water use efficiency	Medium	8	٠	٠	٠	٠		S	\$	✓	✓
AI-7: Increase education and information dissemination	Medium	8	٠	٠	٠			S	\$	✓	✓ ✓
AI-8: Amend WMD rules to create incentives for water conservation	Medium	8	٠	٠	٠	٠		S	\$	✓	✓

³ The "scores" assigned to each alternative have been made by the Department of Environmental Protection, with the benefit of the recommendations of participants in the Water Conservation Initiative.

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⁴ A score of 1 indicates the least water saved, 5 the most.

⁵ A score of 1 indicates the least cost-effective, 3 the most cost-effective.

⁶ A score of 1 indicates relatively difficult to implement, 3 relatively easy.

Water Conservation Alternative	Priority	Total Score	An	nount (of Wa		ved	tiven			men	
	Priority							(1 to 3)	,	((1 to 3) ⁶
Landscape Irrigation												
LI-1: Develop and adopt state irrigation design & installation standards and require inspection.	High	10	٠	٠	٠	٠	٠	S	\$	\$	✓	✓
LI-2: Expand and coordinate educational/outreach programs on water-efficient landscaping.	High	9	٠	٠	٠	٠		S	\$	\$	✓	✓
LI-3: Establish a statewide training and certification program for irrigation design and installation professionals.	High	9	٠	٠	٠	٠		S	\$	\$	✓	✓
LI-4: Develop environmentally sound guidelines for the review of site plans	Medium	8	٠	٠	٠	٠		S	\$	\$	✓	
LI-5: Conduct applied research to improve turf and landscape water conservation	Medium	8	٠	٠	٠	٠		S	\$		✓	✓
LI-6: Establish a training and certification program for landscape maintenance workers.	Medium	7	٠	٠	٠	٠		S	\$		✓	
LI-7: Evaluate the use of water budgeting as an effective water conservation practice	Low	6	٠	٠	٠	٠		S			✓	
LI-8: Evaluate the need to establish consistent statewide watering restrictions for landscape irrigation	Low	6	٠	٠	٠			S	\$		✓	
Water Pricing												
WP-1: Phase in conservation rate structures	High	10	٠	٠	٠	٠	٠	S	\$	\$	✓	✓
WP-2: Require drought rates as part of utility conservation rate structures	Medium	8	٠	٠	٠			S	\$	\$	✓	✓
WP-3: Consider using market principles in the allocation of water, while still protecting the fundamental principles of Florida water law	Medium	7	٠	٠	٠			S	\$	\$	✓	
WP-4: Improve cost-effectiveness in the next cycle of regional water supply plans	Medium	7	٠	٠				S	\$	\$	✓	✓
WP-5: Phase in informative billing	Medium	7	٠	٠				S	\$	\$	✓	✓
WP-6: Require more measurement of water use, including metering and sub- metering												
 a) Sub-metering of new multi-family residences 	Medium	7	٠	٠	٠			S	\$		✓	✓
 Sub-metering retrofit of existing multi-family residences 	Low	6	٠	٠	٠	٠		S			✓	

Water Conservation Alternative	Priority	Total Score	An		of Wa	ter Save	d	tiven	-Effectess	men	of Im ting (1 to 3)	
WP-7: Adopt additional state guidance on water supply development subsidies	Low	6	٠	٠				S	\$	✓	✓	
Industrial/Commercial/Institutional												
ICI-1: Consider establishing a "Conser- vation Certification" program	High	10	٠	٠	٠	٠		S	\$	\$ ✓	✓	✓
ICI-2: Consider a range of financial incentives and alternative water supply credits	High	10	٠	٠	٠	٠		S	\$	\$ ✓	✓	✓
ICI-3: Consider cooperative funding for the use of alternative technologies to conserve water	High	9	٠	٠	٠	٠		S	\$	\$ ✓	✓	
ICI-4: Implement additional water auditing programs	Medium	8	٠	٠	٠	٠		S	\$	✓	✓	
ICI-5: Promote utilization of reclaimed water	Medium	8	٠	٠	٠	٠		S	\$	✓	✓	
ICI-6: Investigate methods of assuring that large users from public suppliers have the same conservation require- ments as users with individual permits	Low	6	٠	٠	٠			S	\$	✓		
Indoor Water Use												
IWU-1: Expand programs to replace inefficient toilets	High	10	٠	٠	٠	٠	٠	S	\$	\$ ✓	✓	
IWU-2: Require that inefficient plumbing fixtures be retrofitted at time of home sale	High	9	٠	٠	٠	٠		S	\$	\$ ✓	✓	
IWU-3: Provide incentives to retrofit inefficient home plumbing fixtures	High	9	٠	٠	٠	٠		S	\$	\$ ✓	✓	
IWU-4: Support national dishwasher and clothes washer standards; offer incentives for purchasing efficient washers	High	9	٠	٠	٠	٠		S	\$	\$ ✓	✓	
IWU-5: Create a water auditor inspection program for the sale of new	Medium	8	٠	٠	٠	٠		S	\$	\$ ✓		
and existing homes, supported by a refundable utility service fee								S				
	Medium	8	٠	٠	•	•		3	\$	~	✓	

Step 5 is finalized by eliminating measures which are infeasible and arranging the remaining feasible measures in logical groups. Identify the specific application of a water shortage management measure (mandatory versus voluntary, residential versus nonresidential).

Evaluate Water Saved by Staged Reductions

The water saved by one of the four stages listed in Table 10 will vary from month to month. Many measures included in the various stages emphasize outside water use reduction. Therefore, their effectiveness will be higher in the warmer months. However, the percentage savings during 1989 and 1990 in the cities of San Luis Obispo and Goleta were as high during the winter as the summer. The public seems to respond with greater efforts to reduce use when winter rains fail to materialize. Some water suppliers find that a rationing plan expected to save 25 percent of the total demand on an annual average basis actually saves as much as 35 percent in the summer months; a correspondingly lower rate of savings, perhaps 15 percent, during the winter. Other water suppliers may achieve a more uniform savings throughout the year.

Exactly how much water savings can be achieved in any given month is difficult to predict. A service area where most of the water use is residential with a large proportion used for landscape irrigation may have high summer savings relative to the annual average. Whereas, a service area with low summer irrigation demands may experience much less variation from the predicted annual average savings.

One way to account for the variation in percent savings is to assume that the savings can be scaled to the normal year demand curve. The predicted percent savings for a given stage in the month of interest is based on the ratio of monthly water use to annual average water use. For example, in Table 11, the percent savings from Stage 1, expected to average 10 percent, may actually vary from 7.7 percent in December to 13.3 percent in July. In 8 out of 12 months the savings may be below the target but the water savings in June, July, and August may result in achieving the annual reduction target. While people over-irrigate more in the spring and fall, their overall water use is higher in the summer, thus the opportunity for greater water savings. Seasonal differences are not as marked in coastal areas as they are inland. This example can be used as a general guideline but will not be accurate in every service area. Implementation of demand reduction programs in unmetered service areas presents special problems and some implementation ideas are provided in Appendix K.

An important way to reduce landscape water use is to limit the time of irrigation to early morning and evening hours. Twice weekly irrigation of lawns is generally adequate but only the customer can determine when and how much their landscape needs. Having all irrigation occur on, for instance, Saturday and Wednesday will make enforcement possible but will upset customers and may result in a peak demand problem. If irrigation is limited to odd/even days of the week, every other day, etc. the water supplier may actually experience an increase in landscape water use. One way to temper the potential impact on peak water demand is to assign watering days based on odd/even addresses.

Customers with odd addresses water on Tuesdays and Thursdays, even addresses water on Wednesdays and Fridays. Customers with multiple addresses on the same property, such as commercial properties are assigned watering days. This is similar to the City of Fresno summer watering schedule except that each group gets three watering days per week.

Schedule water waste patrols to do much of their patrolling in the evenings and early mornings. Restrictions on daytime watering mean that many residents with automatic sprinklers will schedule watering for when they are asleep and sprinkler malfunctions may go unnoticed.

Table 10 Sample Demand Reduction Stages

Stage	Water Supplier Actions	Consumer Actions	Penalties
1. Minimal	Water Suppliers	Residential Customers	Water Waste Penalties
10 to 15 percent shortage	Initiate public information campaign. Explain drought situation to the public and governmental bodies. Explain other stages and forecast future actions.	Implement voluntary water use reductions.	Educational letter or visit
	Request voluntary water conservation. Audit own facilities and repair or replace outdated or equipment, devices, etc.	Adhere to water waste ordinance.	Educational visit and warning
	Advertise toilet, appliance, and equipment rebate programs.	Participate in rebate programs.	3. Citation
	Adopt ordinances banning water waste: i.e.,		3. Citation
	No hosing of paved surfaces.	Commercial Customers	4. Installation of flow restrictor
	No irrigation between 10 am and 5 pm.	Research reuse options.	and possible fine
	No water running into street.		
	Leaks repaired within 48 hours.Recirculating water only in fountains.	Improve cooling tower efficiency.	5. Shutoff and reconnection fee
	Prepare and disseminate educational brochures, bill inserts, etc. Disseminate technical information to specific customer types on ways to save water. Set up public information booths urging water conservation and showing ways the public can save water. Offer	Establish employee 'resource efficiency teams' to identify additional water and energy saving measures.	
	residential water surveys and landscape water audits.	Agricultural Customers	
	Coordinate media outreach program. Issue regular news releases to the media. Begin advertising campaign to remind consumers of the need to save water.	Delay plantings of new permanent crops.	
	Recruit and train employee volunteers for speakers' bureau.		

Table 10 Sample Demand Reduction Stages (continued)

Stage	Water Supplier Actions	Consumer Actions	Penalties
2. Moderate	Water Suppliers	Residential Customers	Water Waste
15- 25 percent shortage	Continue rigorous public information campaign. Explain drought conditions. Disseminate technical information.	Adhere to water waste ordinance.	Penalties 1. Educational letter or visit
	Ask consumers for 15 to 25 percent mandatory or voluntary water use reductions (depending on available supplies for future years.).	Car washed only with bucket and hose with self-closing nozzle.	Education visit and warning
	Ask all restaurants to serve water only on request – increases public	Commercial/Industrial Users	3. Citation
	awareness. Institute rate changes to cause conservation. Explain new rate schedules to customers. Explain	Commercial car washes to increase water recycling.	4. Installation of flow restrictor and possible fine
	further reductions planned in succeeding rationing stages.	Water served to restaurant customers only on request.	5. Shutoff and reconnection
	Lobby for passage of drought ordinances by appropriate governmental agencies.	All Customers	fee Mandatory
	Make showerheads available to public at special depots. Advertise availability of toilet and other device rebates.	Voluntarily set minimum air conditioner temperatures to 75 degrees F unless equipment	Programs 1. Excess use
	Increase efficiency of system water supplies e.g.:	recirculates water.	charges
	Enforce hydrant-opening regulations.	Three times per week watering.	2. Flow restrictors
	Increase meter-reading efficiency and meter maintenance.	Agricultural Customers	3. Fines
	Intensify leak detection and repair program.	Increase orchard maintenance, use of mulching and drip irrigation.	
	Municipal Agencies (parks, school district, etc.)		
	Reduce water use for street cleaning, main flushing & landscaping.		

Table 10 Sample Demand Reduction Stages (continued)

Stage	Water Supplier Actions	Consumer Actions	Penalties
3. Severe	Water Suppliers	Residential Customers	<u>Mandatory</u>
25 to 40 percent shortage	Institute rationing programs through fixed allotments or percentage cutbacks. Require all homes and businesses to have low flow showerheads and toilet	Cars washed only with buckets or hoses equipped with shut off valves and only during specified irrigation hours. All Customers Manage water consumption to stay within water allotments. Suggest weekly water meter reading by customers.	Excess use charges
	displacement devices or ULF toilets before granting an increased allotment.		Flow restrictors
	Prohibit outdoor evaporative mist coolers.		Fines
	Provide incentives for the replacement of water using residential air conditioners.		
	Provide incentives for the installation of no flush urinals.		
	Require installation of ET Irrigation Controllers in all new multi-family, and CII construction.	The filling of ponds, pools permitted only with water provided by tank truck services.	
	Provide incentives for the retrofit of ET irrigation controllers at existing multi-family, and CII customers.		
	Provide incentives for the retrofit of ultra low flush/dual flush toilets in existing single / multi-family, and CII accounts.	Twice weekly watering.	
	Prohibit multiple showerheads that exceed a combined flow rate of 2.5 gpm.		
	Provide incentives for the retrofit of pre- rinse spray valves for food service.		
	Prohibit of hosing of paved surfaces.		
	Prohibit the use of hoses without a shutoff valve.		
	Implement rate changes to penalize use over allotment.		
	Municipal Agencies (parks, school districts, etc.)		
	Pool covers required for all municipal pools.		
	Main flushing allowed only for emergency purposes.		

Table 10 Sample Demand Reduction Stages (continued)

Stage	Water Supplier Actions	Consumer Actions	Penalties
4. Critical	Water Agencies	All Customers	Mandatory
40+ percent shortage	All of the Severe Stage (Phase HI?) steps intensified.	Manage water consumption to stay within water allotments.	Excess use charges
Mandatory reductions	Monitor production weekly for compliance with necessary reductions.	Suggest daily/weekly water meter reading.	Flow Restrictors Fines
	Per capita water use allocations for residential customers.	Landscaping irrigation restrictions including one or more of the following:	
	No potable water used by landscape meters.	Sprinkler ban.	
		Limited irrigation with drip system.	
	Adopt plumbing codes that require the separation of toilet and kitchen sink drainage in new residential construction from the remainder of the wastewater system to enable future reuse.	Irrigation only with graywater or reclaimed water.	
		Once per week watering.	
	Municipal Agencies (parks schools districts)	The topping off or filling of ponds, pools permitted only with water provided by tank	
	All public water uses not required for health or safety prohibited unless using tank truck water supplies or recycled water.	truck services.	
	Irrigations of public parks, cemeteries, etc. permitted only with recycled water.		

Projected drought	Ratio of monthly	Savings by stage, percent		
acre-feet	monthly demand	1	2	4
11,570	0.88	8.83	22.06	44.13
11,980	0.91	9.14	22.85	45.69
12,680	0.97	9.67	24.18	48.36
12,930	0.99	9.86	24.66	49.31
13,420	1.02	10.24	25.59	51.18
16,310	1.24	12.44	31.10	62.20
17,370	1.32	13.25	33.12	66.25
15,950	1.22	12.17	30.42	60.83
12,120	0.92	9.24	23.11	46.22
11,980	0.91	9.14	22.85	45.69
10,920	0.83	8.33	20.82	41.65
10,090	0.77	7.70	19.24	38.48
1	Annual savings goal	10.00	25.00	50.00
	year demand, acre-feet 11,570 11,980 12,680 12,930 13,420 16,310 17,370 15,950 12,120 11,980 10,920	year demand, acre-feet monthly demand 11,570 0.88 11,980 0.91 12,680 0.97 12,930 0.99 13,420 1.02 16,310 1.24 17,370 1.32 15,950 1.22 12,120 0.92 11,980 0.91 10,920 0.83 10,090 0.77	year demand, acre-feet demand to average monthly demand 1 11,570 0.88 8.83 11,980 0.91 9.14 12,680 0.97 9.67 12,930 0.99 9.86 13,420 1.02 10.24 16,310 1.24 12.44 17,370 1.32 13.25 15,950 1.22 12.17 12,120 0.92 9.24 11,980 0.91 9.14 10,920 0.83 8.33 10,090 0.77 7.70	year demand, acre-feet demand to average monthly demand 1 2 11,570 0.88 8.83 22.06 11,980 0.91 9.14 22.85 12,680 0.97 9.67 24.18 12,930 0.99 9.86 24.66 13,420 1.02 10.24 25.59 16,310 1.24 12.44 31.10 17,370 1.32 13.25 33.12 15,950 1.22 12.17 30.42 12,120 0.92 9.24 23.11 11,980 0.91 9.14 22.85 10,920 0.83 8.33 20.82 10,090 0.77 7.70 19.24

Table 11 Variation in Staged Reduction Savings

Lag Time Issues

Water suppliers may assume that they will immediately achieve the levels of water use reduction requested. In areas that have not experienced rationing before, this is unlikely. This is because adjacent water suppliers in the region may have differing messages that may make it difficult to achieve significant water use reductions. For this reason cooperation with other local and regional water suppliers in the development of a consistent drought related message can be very beneficial. Customer response can also be delayed because of the fact that many customers find out their water use only in their bi-monthly bills. With the unseasonably dry hot weather usually associated with droughts, water use can be higher.

By the time water suppliers find out that response is lagging, less water is available for the rest of the year. The likely result of this lag time effect is that water suppliers will have to leapfrog over more moderate rationing levels all the way to severe levels in the spring and summer. Instead of progressing from a Stage II rationing level to a Stage III level, they will have to immediately go from Stage II to Stage IV. This was the experience of many San Francisco area suppliers in 1977 and the experience of even more suppliers in the first years of the 1986-1991 drought.

Another effect of the lag time is that water suppliers may have to draw down emergency storage and overdraft groundwater to make it through later months of the year. That reduces the supply of water targeted to help meet the next year's needs.

This lag time effect is likely to lead to unnecessary economic losses unless it is accounted for by the early setting of significant rationing levels. It is better to have communities ration early at levels that are uncomfortable but manageable than to wait and later have to live with much more extreme rationing.

It is important that the customers hear consistent messages from water suppliers in the region, particularly when they are in the same media markets. There are frequently significant differences in the supplies available to adjacent water suppliers. However if customers served by one water supplier are asked to reduce their water use as much as 30 percent while their neighbors served by another water supplier are only asked to conserve 10 or 15 percent, they will question the equity of the program. This can lead some of them to not meet the reduction needs.

The Sonoma County Water Agency provides the following 2007 example.

Sonoma County Water Agency Drought Conditions, April 2007-October 2007

The Sonoma County Water Agency (SCWA) serves 750,000 users in Sonoma, Marin and Mendocino counties, including the cities of Santa Rosa, Windsor, Rohnert Park, Cotati, Petaluma, Valley of the Moon, North Marin and Marin Municipal water districts.

The Water Agency was told by the State in mid-June to cut its diversions by 15 percent from July 1 to October 28 from the same period in 2004, saving the water in Lake Mendocino for the Russian River's fall salmon run. If water is drawn out at the normal rate, Lake Mendocino would be virtually dry in October when water is needed to support the fall run of Chinook salmon, which are listed as threatened on the federal Endangered Species Act list. While the other major reservoir in the system, Lake Sonoma, is nearly full to capacity, getting more of that water into the Russian River is a problem. The National Marine Fisheries Service limits the amount the Water Agency can discharge from Lake Sonoma's Warm Springs Dam into Dry Creek. Too much water can damage the fishery.

Thus, the Sonoma County Water Agency has embarked on an aggressive water conservation campaign to rein in water use. Each of the contracting municipalities and retail water suppliers implement their own programs to meet the cuts established by SCWA, the water wholesaler. SCWA provides information and daily updates on their Web site at www.scwa.ca.gov and work closely with their local newspaper to keep the public informed. Following are excerpts from the Santa Rosa Press Democrat between April 2007 and October 2007, illustrating how quickly conditions can change, affecting the triggering mechanisms of a WSCP implementation, as well as some typical responses from the public.

April 13, 2007: Water conservation urged; Reservoir could drop to record-low level. County officials are asking everyone to make a (voluntary) effort to conserve between 10 and 15 percent beginning immediately.

April 25, 2007: County seeks river flow cut; Plan could affect farmers, recreation along Russian River during summer.

May 7, 2007: Water woes return; A combination of low spring rainfall levels and new regulations could cause drought conditions in Sonoma, Mendocino and Marin counties by fall.

June 27, 2007: City (Rohnert Park) water savings exceed State order.

July 1, 2007: Mandatory 15 percent water conservation ordered.

July 6, 2007: WATER SAVINGS FALLING SHORT; hot spell blamed for high use, but Water Agency indicates it may take tougher steps. The Sonoma County Water Agency said its customers used 853 acre feet of water between July 1 and July 4 -- 61 acre-feet more than the target of 792 acre-feet.

July 12, 2007: State takes tough line on water savings; Official says while unlikely, county supply could be cut off if conservation falls short.

July 16, 2007: Asking a few questions about conservation. (Columnist asks for a 15 percent reduction in building permits to go with 15 percent cuts in water use.)

July 17, 2007: County steps up water efforts; Next: Officials want State to help limit usage, feds to free more water from Lake Sonoma.

July 17, 2007: 'Water cops' tag homes, threatening \$500 fines. After the first 15 days, the Water Agency is well behind its goal. Use has dropped just 9.9 percent below the 2004 level. If the Santa Rosa doesn't meet its goal or if the Water Agency calls for an even higher conservation level, the city has an emergency program prepared. The program has several levels that include rationing, no water for irrigation, pools and fountains and rules that water for new construction must be offset by savings elsewhere.

July 18, 2007: SCWA TOUGHENS RULES ON WATER USE: Officials next week to reveal allocation figures for each city, water district. Similarly, the Water Resources Control Board warned last week it would consider prohibiting Sonoma County from drawing any water from the river if the conservation order isn't fulfilled. On Monday, the agency plans to tell each contractor what its allocation will be. The allocations will be based on a 15 percent reduction in the 2004 level and will take into account population and per capita water use, so cities will not be penalized for already having strong conservation programs, Water Agency officials said.

July 18, 2007: Petaluma may link escrow, water use; proposed ordinance would require efficiency inspections before property sales. Future homes sales in Petaluma could hinge on water efficiency inspections to determine if plumbing and appliances meet conservation standards. An ordinance being drafted by the city would require the inspections before transfer of ownership of residential or commercial property. The point-of-sale provision is the first of its kind in Sonoma County.

July 18, 2007: Water wasters EDITORIAL; Tougher measures are needed to meet state-mandated goals. Santa Rosa, the largest consumer of water, has already started down this path by sending out "water cops" to look for water wasters. Neighbors may also report water waste by calling a hot line. If problems aren't corrected within 30 days, residents will face fines of \$500 a day. Windsor is also stepping up efforts. At 6 p.m. today a public hearing will be held in the Town Council Chambers on an emergency water ordinance that includes mandatory rationing and a moratorium on new development. It's likely that other cities will need to adopt tough measures -- or expect State regulators to do the dirty work for them by ordering the water agency to turn off its pumps in order to meet the 15 percent cutback requirement.

July 19, 2007: Tipsters key in cutting water waste; as part of conservation effort, cities, districts follow up on anonymous reports of overuse. "It is one of our top 10 conservation tips, to report water waste," Brad Sherwood, a Water Agency spokesman, said Wednesday. The Water Agency, the cities and water districts have set up hot lines for anonymous tips, and the Water Agency also is planning to put a tip form on its Web site, Sherwood said.

DRAFT August 27, 2007

July 23, 2007: Water uncertainty; Consumers, region's water districts scramble to find ways to meet requirement to cut usage of flow from Russian River by 15 percent. The cities and water districts also have provisions to fine or even disconnect their customers who waste water. Those penalties kick in when water conservation measures are made mandatory.

July 23, 2007: Water conservation improves dramatically; Sonoma County Water Agency's latest reading shows 13.1 percent reduction in use, close to 15 percent required by state.

July 24, 2007: Voluntary water conservation urged; Officials see situation as 'generally manageable' as long as everyone is pitching in.... the Water Agency said the cumulative savings since the order took effect July 1 is now 14.2 percent. That's a significant increase from the first four days of July when an 8.5 percent conservation rate was attributed to a hot spell.

The Water Agency wanted to set allocations for its major contractors. The allocations formula put forth by the Water Agency would take into account water conservation programs already in place and are not 15 percent across-the-board decreases.

July 26, 2007: WATER MANDATE LEVEL REACHED; 15 percent reduction achieved in Sonoma, Marin counties; still a 'long way to go' toward conservation, authorities warn. Water officials say it is important to keep up conservation efforts now, because it becomes harder to cut back by 15 percent in September and October. "Now is the highest demand period of the year. It's easier to get conservation," said Chris Murray, principal engineer for the Water Agency. "When you get into the fall . . . it's more difficult to get conservation." But officials were still relieved to have reached their target for now.

August 1, 2007: Efforts to save water paying off; County reports 16.6 percent reduction in diversions from Russian River, urges continued conservation.

August 14, 2007: Wells fill gap in conservation. The *19 percent reduction* in Russian River water use has been achieved by cities' and the county's increasing reliance on their own well water as much as by homeowners getting stingy with their tap water. Water officials in Santa Rosa, Rohnert Park, Petaluma and North Marin reported their total water usage dropped about *10 or 11 percent*.

STEP 6: Adopt the WSCP

Update the WSCP developed for the last UWMP for the current water shortage situation. Each drought or other shortage situation has enough unique characteristics that a general plan cannot specifically define all the scenarios and specific supply and demand management actions. The usefulness of a WSCP lies in planning the range of supply and demand management actions in advance of the situation and in defining the communication mechanisms by which decisions will be made during the event.

Move quickly to formally adopt the updated plan for this drought once it is decided that implementing a water shortage plan may be needed. With public input and noticing requirements plan adoption can take one to two months. The implementation process, running concurrently with the adoption process, can usually be completed within five months. If drought conditions are imminent, the water supplier will need to treat the situation as an emergency, mobilizing the necessary people to develop and implement the procedures to carry out the needed drought phase.

Involve the Community

When the draft is completed, present it at several community forums. If the plan is available for download from the supplier's Web site it will increase the quality of the public suggestions. The community will be more likely to reduce water use if the draft plan incorporates ideas presented at the public forums.

Prepare a Revenue Program

A reduction in water use will mean a revenue shortfall for most water suppliers. This is especially true when the additional costs of purchasing emergency supply and implementing demand reduction programs are added in. There are two common ways of balancing the costs and revenues (budget): (1) raising water rates and (2) imposing a water shortage surcharge. If a Stage 3 or Stage 4 program is initiated rates may have to be doubled to cover fixed costs and extraordinary rationing and supplemental supply expenses. Two additional funding sources that may be available are the financial reserves in the general or water revenue fund and a designated water shortage emergency account.

Raising water rates can include an excess charge for each unit of water over the customer's allotment when rationing is in effect. This helps to reinforce adherence to the allotted amounts. However, anticipating the amount of revenue that will be generated is more complicated when using this method. Some water suppliers have refunded excess use charges if the customer was able to "repay" the excess water during the rationing year. While the refunds are added work for the supplier they build community support and trust.

Table 12 Example Excess Use Charges

Units in Excess of Allotment	Excess Use Charge per Unit	
First bill, excess units	Four times normal rate	
Second bill, excess units	Four times normal rate	
Third consecutive bill, excess units	Ten times normal rate	

Example showing how the rationing stages impact Seattle Public Utilities' Costs and Revenues (SPU WSCP Attachment D, July 10, 2006.

Attachment D

Revenue & Cost Impacts	Stage 1 Advisory	Stage 2 Voluntary	Stage 3 Mandatory	Stage 4 Emergency
Revenue Loss	\$ 1,000,000	\$ 5,000,000	\$ 9,000,000	\$ 13,000,000
Cost Demand Management	\$ 55,000	\$ 1,485,500	\$ 2,935,500	\$ 3,285,500
customer outreach		250,000	650,000	650,000
customer incentives			950,000	950,000
enforcement Cedar Pumping			100,000	300,000
preparation		500,000	500,000	500,000
mobilization	30,000	354,500	354,500	354,500
pumping costs		81,000	81,000	81,000
Seattle wells	25,000	300,000	300,000	450,000
Total: Revenue loss & costs	1,055,000	6,485,500	11,935,500	16,285,500
Financial Tools Used to Mitigate Imp	pacts (descriptions t	pelow table)		
Reprioritize Current Revenue	x	X	x	X
Reprioritize Expenses Withdrawal from Revenue Stabilization Fund		X	x x	x x
Rate Surcharge			x*	x
Notes:				

Notes

- Estimates were created in spring of 2005 for 2005 event. Actual future costs would vary depending on the season, and specific actions taken in a given event. In 2005 SPU entered into Advisory Stage only.
- Above are costs incurred for each stage. The costs for Stages 2 4 include the costs incurred in the previous stage(s). Estimated lost revenue follows the same approach.
- Stage 4 revenue loss estimates here do not include funds that will be brought in by surcharges. Estimates for those surcharges have not been developed.
- * The City may implement a rate surcharge in the Mandatory Stage.

If the water supplier simply wants to recover all of its extraordinary water shortage related expenses and lost revenues necessary to meet fixed costs, a water shortage surcharge can be applied for the duration of the crisis. The water shortage surcharge method is easier to administer and may enable a more accurate prediction of the additional revenue that will be generated. This method is also easier for the customers to understand as a water shortage related charge and not a disguise for a rate increase that may not end when the water shortage is over. As part of the water shortage surcharge ordinance, describe the termination of the surcharge once the crisis is past.

Consider the financial feasibility of funding part of the revenue shortfall from emergency reserves. It may be practical to cover as much as 50 percent of the first year extraordinary expenses and lost revenue from such funds if they are available.

Regardless of the method selected, include the following actions as part of the revenue program:

- 1. Estimate the amount of water use reduction that will be achieved and the associated lost revenue.
- 2. Estimate revenue needs include funds for expensive new water supplies and an extended multi-year rationing program.
- 3. Design a rate adjustment or water shortage surcharge that will cover the anticipated revenue deficit.
- 4. Monitor actual revenue and compare with forecasted revenue; adjust water shortage surcharges as needed (but not too often).

State and federal agencies offer some financial assistance to communities affected by drought. Programs available in 2007 are summarized in Appendix G. Use of such external sources of financial assistance may reduce a water supplier's revenue shortfall. However, most of these are programs of last resort, so be prepared to "go it alone".

Formalize Cooperation with Local Agencies

Draft ordinances and interagency agreements that will be available for adoption for different levels of water shortage. They may contain various levels of mandatory restrictions and provisions that will go into effect when a state of emergency is declared by the governing body.

Regional or cooperative water supplier water shortage contingency planning can provide a common approach to drought management among adjacent water suppliers, identification of emergency supplies, and possibly provide for emergency interconnections or other joint activities. Interagency agreements confirmed in advance will speed response to an emergency and help avoid hurried decisions on matters such as price and equity. Some examples of interagency agreements are identified below.

East Bay Municipal Utility District (EBMUD) and Sacramento County Water Agency Agreement

Looking long-term, EBMUD and Sacramento County Water Agency ended a 35-year legal and political negotiation in 2007, reaching agreement on the Freeport Regional Water Project. When finished in 2010, it will provide 85 million gallons of water a day to Sacramento County Water Agency. During drought years, 100 million gallons a day will be delivered to EBMUD. Sacramento County Water Agency will benefit with the additional protection of the Lower American River and the promotion of water conservation and recycling the project will provide.

Potomac River Agreement

The Potomac River Low-Flow Allocation Agreement provides that in cases of drought, each of the participating agencies would adjust withdrawals to maintain a specific amount of flow in the lower reaches of the Potomac River near Washington, D.C.

California Exchange Agreement

During the 1976-1977 California drought, The Metropolitan Water District of Southern California (MWD), in cooperation with DWR, made water available to Marin Municipal Water District (MMWD) through EBMUD. This State/regional/local water exchange agreement resulted in the construction of an emergency pipeline connecting Richmond and San Rafael, California. This pipeline enabled EBMUD to "wheel" water from MWD through its distribution system to MMWD. The additional water was obtained by EBMUD from a pumping station in the Delta that pumped water that would otherwise be pumped south to MWD. MWD obtained replacement water from its Colorado River Supply that was not experiencing a drought.

Longview, Washington, Agreement

The emergency resulting from the Mount Saint Helens eruption rendered the City of Longview's water supply untreatable and resulted in an agreement among Longview, the City of Kelso, Washington, the Weyerhaeuser Paper Company, and the International Paper Company to supply water to Longview. As this situation illustrates, not all emergencies can be anticipated.

Review and Finalize Plan

Subject the WSCP to a formal public review process. This will help minimize future objections when mandatory provisions are needed. Describe the WSCP elements and the need for them in clear, concise presentations by staff to the board of directors, the public and the media. The Texas Water Development Board has prepared a review checklist for drought contingency plan development by water utilities in Texas http://www.twdb.state.tx.us/DATA/DROUGHT/drought_toc.asp. Such an instrument provides a convenient method to ensure that important items are identified and addressed.

Hold several public hearing on the plan following sufficient notice via the news media. Anticipate opposition and allow for and welcome ideas for beneficial changes to the plan. The green industry, i.e., landscape contractors, nurseries, etc., can mitigate economic harm during a water shortage if they are engaged and informed of potential availability of efficient irrigation systems, graywater distribution systems and other efficient technologies.

With sufficient time and staff contacting industry representatives ahead of time and discussing with them the opportunities and difficulties that rationing will entail may help them understand the reasons for plan requirements. The California Landscape Contractors Association and the Irrigation Association, for example, train and certify their members as certified water managers. They can provide a list of qualified professionals that the water supplier can refer customers to when they need to improve the efficiency of their landscape water use. This is good for business for the landscape industry and good for the water supplier in terms of having confidence in the services being provided.

The message is, "If we reduce water use now, we may lessen the impact of a long drought."

STEP 7: Implement the WSCP

Essential Elements of WSCP Implementation

Implementation of a WSCP requires the following elements:

- 1. Staff levels
- 2. Staff training and support
- 3. Office space
- 4. Equipment
- 5. Budget
- 6. Connecting the silos
- 7. Coordination with other agencies
- 8. Computer and billing format capabilities
- 9. Customer assistance
- 10. Customer appeals
- 11. Special need customers
- 12. Dealing with the media
- 13. Monitoring of actual use

Considerations

Examples of specific drought implementation program needs:

- 1. Staff levels (75,000 people)
 - a. Two full time staff (can use reassignments), three six-month contracts, four interns.
 - b. A tremendous amount of customer contact will occur when rationing or restrictions are announced (when customers receive large "penalty bills" and when appeals are filed). Educate district employees about the rationing program so that they are informed. The workload begins to drop off with six months.
- 2. Training and support
 - a. Integrate new staff into agency.
 - b. Provide training and recognize good performance.
 - c. Interns from local universities can be trained to perform water audits for those customers who exceed their allocations or request assistance. The water audit is

conducted free of charge and the auditors carry showerheads, faucet aerators, washers, plumbing tape and other materials which allow them to instruct the customers on how to make simple repairs. Water auditors also perform landscape water audits, show customers how to set irrigation clocks, and demonstrate the use of soil probes.

d. Train customer service personnel about drought restrictions, so they may easily respond to customer questions.

SEATTLE - A water cop's only responsibility is to enforce the drought response measures. Temporary employees will be recruited for this function, and those hired must be able to interact with the public and communicate the drought restrictions. Thorough background checks are required.

Training. Drought monitors will undergo an intense training program to prepare them to patrol the service area. Dispatchers and data entry staff will participate in the training program, which will address:

- Dealing with irate customers.
- Reading meters.
- Understanding the drought restrictions.
- Operating irrigation systems.
- Passing driving tests.
- Knowing the boundaries of their patrol area.
- Understanding the data entry equipment.

Documentation. Water cops will use hand-held data entry devices that allow them to issue tickets in the field. This system will keep track of the number of violations for each customer and enable the drought monitor to ascertain the appropriate-level violation. Drought monitors will also keep track of stops that did not result in a ticket or written warning but were merely educational in nature.

3. Space

a. Expanded space is essential for new staff. Consider space adequate for high-volume customer traffic - a portable building, store front, etc. (separate from normal functions).

4. Equipment.

- a. Telephones multiple lines, cell phones, new 'hot line number'.
- b. Computers one per person, staff will need current information to provide correct answers.

- c. Cars for appeals, inspections, audits, and water waste patrols.
- d. Audit kits, educational materials, water waste report forms.
- 5. Budget (75,000 people \$150,000 + money for rebates)
 - a. The cost of staff, cars, phones and computers.
 - b. The cost of publicity, rebates, and free showerheads, nozzles, soil probes, buckets, etc.

6. Connecting the silos

- a. Keeping everyone "informed" with regular email updates.
- b. Create a "Shortage Management Team" involving billing, programming, customer service, public relations, operations/engineers, water conservation, and senior management, etc.
- c. Schedule team meetings at least monthly prior to declaring Stage 1, and weekly thereafter.
- d. Present board or policy reports summarizing each department's activities regularly during drought.
- e. Consider tying enforcement and compliance calls directly into utility work order system so as to track and process complaints more rapidly.

7. Coordination with other agencies

- a. Monthly meetings with other suppliers, city and county building & health, emergency services, county agricultural commissioner, etc.
- b. As needed phone and email group contacts for emergencies.

8. Computer and billing formal capabilities

- a. Establish flexible billing and water use history database capabilities.
- b. Adopt a flexible and informative billing format.

9. Customer Assistance

- a. Establish evening and weekend hours, hot-line and Web site information resources.
- b. Provide house calls, efficient landscape irrigation training and meter reading brochure.

10. Customer Appeals

- a. Rationing manager & appeals committee make decisions.
- b. Staff can either be used for processing appeals or assisting customers to make permanent efficiency changes design appeal process to ask for water efficiency changes from customers.

- 11. Special needs customers hospitals, laundromats, etc.
 - a. Recognize special needs but do not "roll over" require efficiency upgrades.
 - b. Audits are always necessary.
- 12. Dealing with the media publicity, customer privacy, consistency
 - a. Free news coverage the most effective tool.
 - b. Keep the message consistent.

Activate a Public Information/Media Program

Public involvement needs will require an expansion of an existing water conservation public information program. A vigorous public education program during a water shortage emergency is crucial for achieving substantial water use reductions. The water supplier assumes a central role in publicizing the extent of the water shortage problem as well as in advising and assisting consumers to conserve. Even voluntary programs have achieved significant reductions in water use in situations where the public was well-informed and understood the need to conserve.

Aim a public education program at five basic groups:

- 1. **Provide information to local decision-makers** regarding why certain actions are needed, why special arrangements for communication and coordination will be called for, and the possible need for both emergency funds and emergency powers.
- 2. Encourage governmental bodies (park and fire departments, universities, recreational facilities and other water-dependent agencies) to provide leadership by taking timely actions to reduce demand and provide examples to the public. Government cooperation can go beyond the efforts being asked of the public and offered quickly and at the initiation of the agencies themselves. The water supplier takes the lead and works with the local elected officials and the media to promote cooperation and commitment from government institutions in its service area. Experience has shown that government institutions are willing to respond, especially if provided with technical guidance.
- 3. **Provide detailed information to industries, schools, businesses, and other groups** that are asked to comply with specific use restrictions. Also, call upon these groups to suggest alternatives to the proposed rationing program that can possibly achieve an equivalent level of demand reduction with potentially less economic harm. Innovative ideas have been generated by the private sector in past droughts. As a minimum, this approach will help ensure willing participation by demonstrating a genuine interest in their perspective.
- 4. **Provide frequent briefings to the news media** to ensure timely and accurate communication of information. Be especially watchful for human-interest stories that could help convey the "shoulder to the wheel" attitude desired among their customers. Informing the media of specific instances of an individual or group making sacrifices

for the common good is a way the water supplier can show appreciation for conservation efforts.

5. **Provide information to the general public on a regular basis** about the water supply situation, what actions are being proposed and/or being taken, how those actions will mitigate supply shortages, and how well they are meeting program goals.

When appealing to customers for water use reductions, act equitably, credibly and consistently. Demonstrate to the public that the water supplier is doing everything possible to minimize the shortage. Pursue supply options vigorously; if new supplies are too costly or not achievable in a short time frame, communicate that fact. Publicity about changes in water supplier operation and maintenance practices that conserve water is helpful. Also, provide accurate information concerning supply status (reservoir and ground water levels), water use reductions, and other pertinent information to all company personnel, especially those briefing the media or involved with public education, as well as meter readers and billing department employees.

Developing the pubic information campaign takes time. The Denver Drought Plan includes the following media implementation plan.

Once the Board has identified a specific drought stage, Denver Water's Community Relations staff will develop an appropriate communications plan based on the elements specified in the Outline for a Drought Communication Plan.

February

- Select advertising agency to assist staff with mass media advertising campaign.
- Announce "Spring Watch" (voluntary ban on lawn watering), subject to Board decision.
- Promote relevant news story topics to media and respond to media inquiries.

March

- Begin developing message-of-the-week program.
- Reinforce voluntary ban on lawn watering.
- Board contracts with ad agency.
- Community Relations staff and agency begin work on campaign.
- Hold public meeting about surcharges.
- Promote relevant news story topics to media and respond to media inquiries.

April

- Begin disseminating message of the week.
- Reinforce voluntary ban on lawn watering.
- Promote relevant news story topics to media and respond to media inquiries.
- Board determines drought stage and corresponding drought response measures.

- Post drought stage and response measures on Web site.
- Intensify media relations.
- Community Relations staff prepares and mails notices to all customers.
- Board approves ad campaign.

May

- Disseminate message of the week.
- Ad campaign begins.
- Mail notices of drought response measures to all customers.
- Promote relevant news story topics to media and respond to media inquiries.

In dealing with the media, have one person speak for the water supplier - preferably the water shortage response team leader. Make immediate response to media inquiries to maintain communication links and to avoid media representatives seeking alternative information sources that are probably less informed. Good communication provides opportunities for a water supplier to tell its story and ensures that knowledgeable people will be called upon to speak on the issues.

Before developing water shortage-related public information strategies, there are several important issues to keep in mind about program focus and content. First, emphasize that the water supply situation is unpredictable and may change from month to month. No one can be certain when the situation will improve. Even if precipitation increases, the effect on the water supply may not be immediate. The water supplier needs to proceed cautiously by starting demand reduction programs early and avoid relaxing any measures too soon. Also, customers need to realize that the drought impact is not uniform across a state or region and that the problem will be more severe in some areas and less severe in others.

Some user classes may carry the burden of coping with the water shortage more than others. Some groups with high potential for reduction may be asked to reduce water use more than others, but avoid discrimination within a class of customers. Landscape irrigation may have to be curtailed. Conversely, it may be decided to minimize water reductions to commercial/industrial customers in order to preserve as many jobs as possible. Carefully communicate the reasoning behind these or any mandatory curtailment of supplies.

Make the public aware of the impact of the water shortage on water system costs as early as possible. Reduced water sales will obviously reduce revenue. Most water suppliers have fixed costs on the order of 75 to 80 percent of their total budget and this fact needs to be communicated to the public. There may be significant additional costs incurred for purchasing water, conservation programs, emergency pumps, pipes, and other equipment, increased water quality testing, and other water shortage related activities. These costs will be borne by the system users.

Finally, avoid being placed in an adversarial position. Focus on the emergency at hand without blame implied towards the water supplier's management or any customer class.

It is important to tailor the public information program to the type of community served. For large decentralized areas, methods that allow the water supplier to reach many customers relatively inexpensively such as websites, email, direct mail, bill inserts and media advertisements are appropriate. Smaller, close-knit communities with central business districts may also be well served by a central information center.

Public information programs provide long-term benefits by increasing the customers' understanding of their water use and of the water supplier's operations. Such an understanding will be useful in generating public support for future efforts regarding rate increases or new efficiency and supply projects.

When undertaking any public information effort, it is crucial that the information be accurate and consistent and that requested use reductions be commensurate with the seriousness of the situation. In other words, the customer must understand what the trigger conditions are, what the consequences of the different stages of drought are, and how the emergency measures will help relieve or minimize the problem.

13. Monitoring of actual use

- a. Chart actual water supply and demand on a graph. A seven-day average can be used to smooth out daily fluctuations. Update this graph weekly.
- b. Compare actual demand and supply with projected demand and supply to determine if stage adjustments may be needed. Prior to altering the demand reduction stage, consider any program adjustments such as raising the level of expenditure on public information and/or increasing enforcement efforts. If this does not achieve the required stabilization, adjust the stage.

Continuously monitor the effectiveness of the individual conservation measures, supply availability, and actual water use. The following procedure is suggested:

The Seattle plan recognizes that the impacts of drought during different seasons have different impacts. They found that it is essential to closely monitor water quality during droughts and particularly during a warm weather drought. This applies to water quality in rivers as well as to the drinking water provided to customers. Water quality issues must be considered for drinking water and instream uses when supply management decisions are made. The Seattle water distribution system is designed to carry a large capacity of water during summer peak months. If demand is significantly lowered, water will not move through the system at the "design" rate. The slower moving water, coupled with higher summer temperatures will increase the likelihood that drinking water quality problems may arise.

Planning timeline

Modify your general drought plan to meet the specific conditions of the drought that is possible in the next year or two. Begin six months before you know for sure that you will have to implement a rationing plan. Most water suppliers are able to forecast the likelihood of drought related supply shortages a year before they occur. Six to eight months is a reasonable amount of time to develop an effective, equitable rationing plan that your staff can implement smoothly.

Why does good rationing planning take at least six months? Let's assume that the rationing will take effect on May 1st - that means planning would begin on November 1st.

- On November 1st a staff member is requested to research and draft an updated rationing plan. This individual will become very familiar with the plan and perhaps will be the rationing manager.
- Two weeks later the draft plan is ready for staff review. The General Manager and Department heads review the plan and the underlying assumptions and suggest changes. The plan is modified and expanded to include implementation procedures.
- A week later, affected staff are asked to review the impact of the plan on their functions customer service, billing, computer programming, budget, operations, etc. to ensure that the plan as written is 'workable.'
- It is now mid-December and a subcommittee of the elected Board reviews the plan, suggests changes, and sends the plan to the Board for review and action.
- During early January the full Board reviews the final draft of rationing plan and schedules public hearings
- Staff finds a large meeting room, prepares presentation materials, designs the news releases and advertisements and by mid-February sends out the public hearing announcements (direct mail, paid ads, news stories). This information includes rationing plan specifics and invites public input at a series of hearings.
- The first public hearing, late February, with hundreds of customers attending, results in public pressure to revise specific elements of the plan.
- At the second public hearing, in early March, usually with only half as many customers attending, suggested changes to the plan are reviewed and public input continues. The Board declares a Water Shortage Emergency (the rainy season is almost over).
- At the last public hearing, in mid-March, with hundreds of customers still in attendance, the staff reviews public suggestions, presents a variety of rationing plans for Board consideration, and the Board selects a plan.

- By the end of March all customers are notified by direct mail that mandatory rationing has been adopted and how the plan will affect them.
- By mid-April customers receive individual letter with an allotment for that account, description of rationing plan and appeal procedure, general rationing/information brochure, and conservation information on how to reduce use (efficient toilets, showerheads, landscaping, meter reading, leak repair, etc.).
- On May 1st rationing begins.

This is a tight time line and requires that one staff member be responsible for keeping the momentum going. As each winter storm arrives, the motivation to maintain the rapid pace will decrease. It is important that someone be responsible for this process and, in most cases, the Water Conservation Manager becomes the Rationing Manger. This makes sense in that the conservation staff is aware of how customers can reduce use, has public education and assistance experience, and conservation programs will become essential to the success of the rationing plan.

While the rationing manager is orchestrating the rationing plan approval process, the agency can also start preparing for implementation. Support from the General Manager is essential, since the rationing manager will need to hire staff, spend money, act as media spokesperson, call staff meetings, etc.